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ARGON; THE NEWLY-DISCOVERED CONSTITUENT OF THE AIR.

By GEORGE MCGOWAN, Ph.D.

THOSE votaries of science and others who were privileged to take part in the meeting of the Royal Society, which was held in the theatre of the University of London on January 31st, will look back upon the day as a red-letter one in their lives. As another writer has already remarked, the scene at the meeting—crowded as that was with so many who have made a name for themselves in the scientific world—was in many respects unique, and it will certainly be historical. This meeting, as it fitly happened, was the first to be held under a new rule of the Society, passed by the Council last session, whereby not more than four meetings in any one year are to be devoted to the hearing and consideration or to the discussion of some one important topic, and it was the first to which the general public and reporters were admitted. On that day Prof. William Ramsay read to the Society the paper by Lord Rayleigh and himself upon "Argon," the newly-discovered constituent of air, a communication which had been looked forward to with intense interest ever since the meeting of the British Association at Oxford last August, when Lord Rayleigh made a verbal statement about the new gas on behalf of his colleague and himself. The effect of that statement upon the audience at Oxford may be better imagined than described. It seemed incredible that we should be hearing to-day for the first time of a gas which constitutes something like one per cent. by volume of the air we breathe, and that its presence should have been overlooked by chemists and physicists all these years. But no one can now have a shadow of doubt that such has really been the case, and that a new constituent of the atmosphere—whether elementary or a mixture of two or more elements remains to be decided—has been brought to light. Hitherto it has lain hidden among the nitrogen of the air, and has been reckoned as part of that nitrogen.

It may not be without interest to the readers of KNOWLEDGE to turn back for a few minutes to the history of the discovery of the two main constituents of air, nitrogen and oxygen (leaving out of account the water vapour, carbonic acid, and the small quantities of other substances found in normal air), before proceeding to the consideration of the new gas. The first observation which aided in overthrowing the old assumption that the air was a simple substance was the noting of the effect upon an enclosed volume of air of burning a combustible substance, or of heating certain metals in it. This led Robert Boyle, so long ago as the latter half of the seventeenth century, to the conclusion that one ingredient of the air was necessary to respiration and combustion, and to the calcination of the metals, although neither he nor his contemporary Mayow (who came pretty near to the true interpretation of combustion) was able to isolate it. The disputed question as to whether atmospheric air was a simple substance or a mixture was finally solved experimentally by the chemists of the phlogistic era, more especially by Scheele and Priestley, but it was left to Lavoisier to put the proper interpretation upon the results which they had obtained. Nitrogen was first isolated by Scheele, although Rutherford, Professor of Botany in the University of Edinburgh, working independently, obtained it from the air in 1772, and published the record of his experiments before Scheele did. Again, with regard to oxygen, we now know from papers which have quite recently come to light,* that Scheele succeeded in isolating oxygen in 1771–1773 from several different compounds (peroxide of manganese, nitrates, red oxide of mercury and oxide of silver), and characterized it thoroughly; while Priestley, also working independently, first isolated it for certain (from red oxide of mercury) in 1774. The latter, having published his results prior to Scheele, has hitherto been regarded as the discoverer of oxygen. By this important discovery both of those chemists were in a position to recognize air as a mixture of gases. In 1785 Cavendish read a paper entitled "Experiments on Air"† before the Royal Society, in which he proved the identity of "phlogisticated air" (nitrogen) with the constituent of nitric acid; this last he showed to be formed when a series of electric sparks was passed through a mixture of nitrogen and oxygen contained in a tube closed at one end, soap lees (*i.e.* caustic potash) being used to absorb the acid vapours as they were produced. In those experiments, which extended over many days and which were of necessity made with a very small quantity of material, Cavendish observed that, after all the oxygen and nitrogen in the tube had been used up, a slight residue of gas (not exceeding the

* See E. von Meyer's *History of Chemistry*, Second German Edition.

† *Philosophical Transactions for* 1785, Vol. LXXV.; also republished in the *Alembic Club Reprints*, No. 3.

$\frac{1}{120}$th part of the nitrogen employed) remained unabsorbed, and this led him to surmise the possible existence of still another constituent in the atmosphere. The passage in Cavendish's paper which relates to this is so important that it was quoted by Lord Rayleigh and Prof. Ramsay at full length, and it is reproduced here for the benefit of those who are curious with regard to the history of the subject. It runs as follows (for phlogisticated air read nitrogen, and for dephlogisticated air read oxygen):—

"As far as the experiments hitherto published extend, we scarcely know more of the phlogisticated part of our atmosphere, than that it is not diminished by lime-water, caustic alkalis, or nitrous air; that it is unfit to support fire, or maintain life in animals; and that its specific gravity is not much less than that of common air: so that, though the nitrous acid, by being united to phlogiston, is converted into air possessed of these properties, and consequently, though it was reasonable to suppose, that part at least of the phlogisticated air of the atmosphere consists of this acid united to phlogiston, yet it might fairly be doubted whether the whole is of this kind, or whether there are not in reality many different substances confounded together by us under the name of phlogisticated air. I therefore made an experiment to determine, whether the whole of a given portion of the phlogisticated air of the atmosphere could be reduced to nitrous acid, or whether there was not a part of a different nature from the rest, which would refuse to undergo that change. The foregoing experiments indeed in some measure decided this point, as much the greatest part of the air let up into the tube lost its elasticity; yet, as some remained unabsorbed, it did not appear for certain whether that was of the same nature as the rest or not. For this purpose I diminished a similar mixture of dephlogisticated and common air, in the same manner as before, till it was reduced to a small part of its original bulk. I then, in order to decompound as much as I could of the phlogisticated air which remained in the tube, added some dephlogisticated air to it, and continued the spark till no further diminution took place. Having by these means condensed as much as I could of the phlogisticated air, I let up some solution of liver of sulphur to absorb the dephlogisticated air; after which only a small bubble of air remained unabsorbed, which certainly was not more than $\frac{1}{120}$ of the bulk of the phlogisticated air let up into the tube; so that if there is any part of the phlogisticated air of our atmosphere which differs from the rest, and cannot be reduced to nitrous acid, we may safely conclude, that it is not more than $\frac{1}{120}$ part of the whole."

The above passage serves to throw in clear relief the marvellous gift of observation and experiment by which Cavendish was distinguished. There can thus be no doubt that he actually separated from the nitrogen of the air, and had in his hands a minute quantity of the new gas, but more than a century was to come and go before anything further was to be heard about it. The experimental facilities which Cavendish could command were so primitive that we can only marvel at his having made this observation, and not at his carrying the matter no further. But why, it may be asked, was a century and more allowed to pass before the thread was again taken up, and argon discovered? This no doubt arose in part from the fact that comparatively few chemists were aware of Cavendish's surmise, while those who were aware of it neglected to give it its proper weight, on the assumption that Cavendish was mistaken in his experiment and deductions; and further, as we shall see presently, the experimental difficulties to be overcome were of necessity very great.

It is not my purpose to enter into minute detail with regard to the discovery and the investigation of argon. I shall merely touch here on some of the more salient points. The observation which ultimately led to the discovery of the new gas was one made by Lord Rayleigh, who had been engaged for a long time in re-determinations of the densities of various gases, including nitrogen, those determinations being made with all possible precautions, so as to reduce experimental errors to the lowest practicable limit. He observed that the nitrogen prepared by various methods from different chemical compounds (nitric oxide, nitrous oxide, ammonium nitrite and urea) was lighter than atmospheric nitrogen by about half a per cent., under equal conditions of temperature and pressure; or, to put the matter in other words, he found that two hundred and thirty volumes of atmospheric nitrogen weighed as much as two hundred and thirty-one volumes of "chemical" nitrogen.* This discrepancy in weight was so unlooked for that he at first attempted to account for it on the supposition that there had been contamination of the nitrogen in question with some other gas, or that there had been a partial dissociation of the nitrogen molecules into atoms. But these hypotheses having been put to the test of actual experiment without result, it was felt that the only remaining explanation must lie in one of the two nitrogens being a mixture of gases, and that in all probability it was the nitrogen of the air. Prof. Ramsay now joining forces with Lord Rayleigh, they set to work upon a rigorous search for the suspected gas, and after much arduous and patient labour on many different lines, their efforts were crowned with success.

A variety of methods were tried in order to isolate the gas, but of these we need only mention three here, the first two being found to answer well: (1) Cavendish's old method on an immensely larger scale, or, to speak more correctly, at a rate of combination of the oxygen and nitrogen far beyond what was possible with Cavendish's appliances, the highest rate yet attained being about three thousand times that of Cavendish. This method, it will be remembered, was to go on passing electric sparks through a mixture of atmospheric nitrogen and excess of oxygen contained in a vessel inverted over a solution of caustic alkali, the gases being fed in alternately as required. After no further diminution in volume took place on continued sparking, the excess of oxygen was absorbed by alkaline pyrogallate, and there remained a residue of a gas whose spectrum showed it to be neither nitrogen nor oxygen. (2) Atmospheric nitrogen was passed backwards and forwards from one gas-holder to another over red-hot magnesium turnings contained in combustion tubes, whereby the nitrogen was somewhat slowly taken up as magnesium nitride, while there remained a residue of unabsorbed gas. This, like the sparking, was a very tedious operation, and necessitated the use of a somewhat complicated series of tubes containing soda-lime, phosphoric anhydride, red-hot copper, and red-hot copper oxide, in order to get rid of every trace of other possible gases, the whole arrangement being worked by a Sprengel pump. During the first stage of the absorption large gas-holders containing water were used, and finally, after most of the nitrogen had been absorbed, smaller gas-holders containing mercury. Both of these methods (1) and (2) were found suitable for the preparation of argon on a large scale, *i.e.*, in quantities of a litre or more at a time. In their paper the authors enter minutely into the various steps of the operations, and detail all the precautions which they employed so as to insure getting the argon pure. (3) The third method to which we have

* *Royal Society's Proceedings*, LIII., 134 (1893); LIV., 340 (1894).

alluded, and which yielded interesting qualitative though not quantitative results, was Graham's method of diffusion or atmolysis. Every student of chemistry and physics knows that when a mixture of two gases of different densities is made to pass through a finely porous material, such as the walls of a common clay pipe, the lighter gas passes through the pores, or diffuses, more rapidly than the heavier; the rates of diffusion being inversely as the square roots of the densities of the gases. To give an example, oxygen has a density sixteen times as great as hydrogen. When a mixture of those two gases is made to diffuse through the walls of a clay pipe, or a cylinder of unglazed earthenware, it is found that four volumes of hydrogen pass through for one volume of oxygen. The experiment can be tried very easily with coal gas and air, the former being, of course, the lighter of the two. By this means the slower diffusing portion of atmospheric air was found (after removal of the oxygen by red-hot copper) to have a density greater than that of ordinary atmospheric nitrogen, and that to an extent beyond the limits of experimental error. This, of course, leads to the conclusion that atmospheric nitrogen is a mixture of gases. It should further be mentioned that "chemical" nitrogen was treated by methods (1) and (2), *i.e.*, sparked with oxygen and passed over red-hot magnesium, in exactly the same manner as the atmospheric nitrogen had been, but in neither case was more than a trifling amount of argon obtained, an amount readily accounted for by errors of experiment. We have in this a definite proof that argon is *not* present in the nitrogen obtained from chemical compounds.

There has, of course, not been time yet to make a full investigation of the properties of argon, although much of interest in this respect has already been done. A number of determinations of its density have been made, which show this to be 19·9 (hydrogen = 1). A calculation made by the discoverers on the assumptions (1) that the accurately-known densities of atmospheric and of chemical nitrogen differ only because of the argon present in the former, and (2) that during the sparking with oxygen nothing excepting nitrogen is oxidized, gave the figure 20·6 as the theoretical density. The difficulty in determining the density of the new gas accurately is to make sure that every trace of nitrogen has been removed. The sample of density 19·9 showed no spectrum of nitrogen when examined in a vacuum tube. Even if this figure should have to be amended slightly, it is obviously very near the truth. Argon is thus nearly half as heavy again as nitrogen, whose density is 14.

The spectrum of argon was examined by Mr. Crookes, the well-known authority on spectroscopy, who himself read a short supplementary paper upon this at the meeting. He found that it resembled nitrogen in that it gave two distinct spectra, according to the strength of the induction current employed. But while the two spectra of nitrogen are different in character, one showing fluted bands and the other sharp lines, the argon spectra both consist of sharp lines. Under certain conditions of working the spectrum is rich in red rays, and under other conditions in blue. Mr. Crookes was able to take photographs of the two spectra of argon, partly superposed, when their dissimilarity was readily seen. He further found that no other spectrum-giving gas or vapour yielded spectra at all like those of the new gas. Judging from the spectra, therefore, he gave it as his opinion that argon was not improbably a mixture of two or more gases (a contingency which had likewise been foreseen by Lord Rayleigh and Prof. Ramsay from their own observations), one of those gases glowing red and the other blue, and each having its own distinct spectrum. On the other hand, it must not be forgotten that some elementary gases with which we are well acquainted, *e.g.*, nitrogen, also possess two distinct spectra. So far, therefore, as spectroscopic work can decide, Lord Rayleigh and Prof. Ramsay have added one, if not two members to the family of elements.

The behaviour of argon at very low temperatures was investigated by Prof. Olszewski, of the University of Cracow, who has made a special study of this branch of chemistry. He found, among other things, that its freezing point is —189·6° C. and boiling point —187° C., while the density of liquid argon at the boiling point is 1·5 approximately (water = 1). It is interesting to note here that the density of liquid oxygen is only 1·124. Argon thus belongs to the so-called permanent gases, and its behaviour on liquefaction places it nearest to oxygen, which boils at —182·7° C.

From the ratio of the specific heat at constant volume to that at constant pressure, the discoverers have come to the conclusion that argon, like mercury vapour, is a *monatomic* gas; its atomic weight is therefore about 40 (*i.e.*, 19·9 × 2). This raises, however, some very difficult points, which require further working out; for, as Lord Rayleigh himself said towards the close of the meeting, the monatomicity of a gas is a subject about which we know exceedingly little, mercury vapour being the only other monatomic gas known.

Argon dissolves in water to the extent of about four volumes in one hundred of water at the ordinary temperature. Its solubility is thus much the same as that of oxygen, and about two and a half times as great as that of nitrogen. It has therefore been found, as was to be expected, that the dissolved "nitrogen" from rain-water is relatively more than twice as rich in argon as atmospheric nitrogen is.

All attempts to induce the new gas to enter into chemical combination with any other element have up to the present proved abortive—hence the name given to it—argon or idle. It does not combine with oxygen in presence of alkali under the influence of the electric discharge, nor with hydrogen in the presence of acid or alkali, or when sparked, nor with phosphorus or sulphur at a bright red heat. Tellurium, sodium and potassium may be distilled unchanged in a current of the gas. It is unaffected by passing it over red-hot caustic soda, soda-lime, potassium nitrate, sodium peroxide, the persulphides of sodium and calcium, nascent silicon and nascent boron. Platinum black and platinum sponge do not absorb it, and wet oxidizing and chlorinating agents—such as permanganate of potash and aqua regia—are entirely without action upon it. Experiments are in contemplation to see if it will combine with fluorine, the most active, in a chemical sense, of all the elements. These present, however, exceptional difficulties, and time will be required to carry them out. An attempt will also be made to produce a carbon arc in the gas. Under other conditions argon may yet be found capable of entering into chemical combination with some of the other elements, for, as the authors pointed out in their paper, it is comparable at the ordinary temperature with mercury vapour at about 800° C., and the compounds of mercury are by no means stable at a high temperature in the gaseous state.

In summing up the arguments which have been already advanced in favour of argon being a new substance, Lord Rayleigh and Prof. Ramsay call further attention to the point that it is in the highest degree improbable that two processes so different from one another should manufacture the same product, whereas the explanation is simple if it be granted that these processes merely eliminate

XUM

nitrogen from an atmospheric mixture. Again, a monatomic gas can only be an element, or a mixture of elements; hence it follows that argon is not of a compound nature. Some of Prof. Olszewski's results point strongly to argon being a single element; on the other hand, Mr. Crookes' spectroscopic work is in favour of its being a mixture. On the whole the discoverers are inclined at present to regard argon as one elementary substance, but they are careful to state that this opinion is merely tentative, and may be overset by subsequent investigations. There is only one other point to which we would refer here. If argon should ultimately prove to be a monatomic gas with an atomic weight of about 40, there would then be no place for it in Newlands and Mendeléeff's "Periodic System of the Elements," the greatest generalization of modern chemistry; the "Periodic Law," which has already done such wonders towards the discovery of new elements, would, therefore, require revision. On the other hand, should argon prove to be a mixture of two or more elements, these might quite conceivably fill up gaps in and conform to the periodic system. But it would be premature to speculate further upon this point until we have more actual knowledge of the new gas. What strikes one forcibly in reading the abstract of the paper is the great number of important issues which it suggests for further investigation. And who knows but that in time the gas may fill an important industrial *rôle*—may be doing so just now, in fact, for anything we can tell to the contrary? Prof. Roberts Austen made a suggestion of this nature with regard to the possible part played by argon in the manufacture of Bessemer steel.

One thing, so far, is certain, viz., that a gas, be it one element or a mixture of two or more, which has eluded discovery for the past hundred years, is now made known to us. And there can be but the one opinion that this discovery, the result of so much patient and far-sighted investigation, will take its place in the history of science as one of the most brilliant achievements of our day.

A MYTH OF OLD BABYLON.

By Theo. G. Pinches, M.R.A.S.

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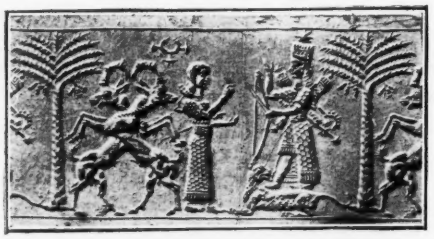
THE literature of Assyria and Babylonia has of late years received such remarkable additions, that it promises to be an inexhaustible storehouse of information as to the ancient life of the East, among the Semites, and the most important thing for the early history of the civilization upon which that of to-day is founded. The discoveries of Layard and Rassam, mostly at Nineveh, resulted in the finding of twenty thousand fragments of tablets, to which later excavations have added a few thousands more. Sixty thousand fragments were the result of Rassam's excavations at Abu-abbah (Sippara), Babylon, and other places, and the French and Americans have since made very successful excavations at Tel-loh (Lagash) and Niffer (Nippur). The durability of the material employed (baked and unbaked clay) makes it extremely probable that the large collections of tablets which exist in the various great museums of Europe and America will be enormously supplemented as time goes on. The remarkable discovery of letters from Palestine, Tyre, Sidon, Babylon, and elsewhere, at Tel-el-Armana, in Egypt, eight years ago, forms a most important addition to our store of documents bearing on the history of the ancient East.

Though the number of fragments of legends is comparatively small, it is easy to see, from the care with which these texts are generally written, that they were thought much of by the ancient inhabitants of Assyria and Babylonia. Unfortunately, all, or almost all, are in a very incomplete—not to say fragmentary—state, but this is a defect that will probably be removed as time goes on, and discoveries bring to light the missing parts.

Probably the most complete of the myths of old Babylon is that which relates the descent of the goddess Istar into Hades. It has often been published, the first attempt having been made by the well-known scholar and scientist, Fox Talbot, in 1865. Later, Mr. George Smith, having recognized and joined on the missing fragment of the legend, published an almost complete translation of the text in the *Daily Telegraph* of August 19th, 1873. Lenonnant, Schrader, Sayce, and other scholars, have also furnished renderings of this highly interesting legend.

It is possible that some of the readers of Knowledge may be unacquainted with the drift of the story. Istar goes down to the land of Nugia ("No-return") demanding, with threats, admission to that region. The porter goes to Eres-ki-gala, the queen of Nugia, for instructions, and she tells him to admit the goddess Istar, but to do to her according to his former instructions. Istar then passes through the seven gates of Hades, led by the porter, who takes away from her, at each gate, a part of her clothing and jewels, from "the great crown upon her head" to "the garment of the nakedness of her body." At each gate she asks him why he has taken the jewel or



Istar standing on an Animal, with a Priest worshipping before her.

the garment, as the case may be, away; but his only answer is "Enter, lady, for these are the commands of the lady of the land."

After Istar's arrival in Hades, Eres-ki-gala saw her, and a violent quarrel (to use comparatively mild language) ensued, ending in the queen of Hades calling up Namtar (the spirit of fate), her messenger, whom she commanded to strike Istar with disease of the eyes, sides, feet, heart and head. The result of Istar's absence from earth began, however, after a while, to make itself felt, for neither animals nor mankind fell in love any longer, and "the great gods," having heard of the state of affairs, resolved to take action in the matter, the outcome being that the god Êa created a monster called "Uddusu-namir, the *assinnu*," a creature apparently having many heads, whom Eres-ki-gala, the queen of Hades, was at first inclined to resist, and against whom she uttered threats of imprisonment, accompanied by various indignities—threats which seem to have been all in vain, because of the divine powers with which Uddusu-namir, the messenger of the gods, had been endowed. This being the case, she judged it prudent to yield, and sending for Namtar, her messenger, again, she commanded him to bring forth a genius called Anunnaki—a spirit of the earth—who, when he came, gave to Istar, at the command of Eres-ki-gala, the waters of life, and, leading her again through the seven gates of

Hades, returned to her her garments and jewels, beginning with "the robe of the nakedness of her body," and ending with "the great crown of her head." The end of the inscription consists of a lamentation for Tammuz, her spouse, whom she had failed to release, and had left in the gloom of the Underworld. "Sprinkle thou the glorious waters, [pour thou out] the sweet oil for Tammuz, the husband of [my] youth," she seems to say, and then she appears to call upon her worshippers, and the male and female mourners who mourned for Tammuz, to play for her "the flute of lapis-stone," upon the day of Tammuz, whom she affectionately calls her brother—"my only brother"—as was the custom in Babylonia in ancient times.*

Such is the story of Istar, daughter of the god Sin, when she descended into Hades.

𒌋𒀭 𒐕𒐕𒐕 is the monogram for the god Sin (the moon) as god of the thirty (𒐕𒐕𒐕 = XXX) days of the month.

Another legend referring to "the daughter of Sin," however, has recently come to light. Unfortunately, it is very imperfect, but sufficient remains to make it a literary fragment of great interest. What we have of it is inscribed on a piece forming the lower part of the obverse and the upper part of the back of a large tablet of baked clay found by either Layard or Rassam at Nineveh. When complete, this document must have contained four columns of writing, in the Babylonian cuneiform character, of about sixty lines each. Of these possible two hundred and forty lines, however, only eighty-two remain, many of them very incomplete, and as the text is given in two languages, Sumerian and Semitic Babylonian, the portion of the legend which remains is, as may be imagined, a mere fragment, though, from its nature, it must be regarded as an important one.

Fragment of a Tablet in the Babylonian Character from Nineveh. (Obverse.)

In the first column (which has only fifteen incomplete lines—that is to say, eight real lines, when we take into consideration that the text is bilingual), the heroine (for it is she who seems to be the narrator) tells of some person who caused evil, who had plundered the land, and who had carried off "the fair son." This person seems to have prevented something from being completed (perhaps the temple of the city), and, judging from the remains of the inscription in that place, the person spoken of seems to have imprisoned one of the inhabitants of the land, and caused others, possibly his own followers, to settle in the region.

The fracture of the tablet has broken away the upper part of column II. Where the text becomes legible, the heroine is speaking of a journey made in a ship, and of the treatment she had received at the hands of "the enemy"—apparently the person spoken of in the first column as having spoiled the land, and carried off "the fair son." As this part of the text is fairly complete, and very poetically written, I give it here in the words of the original:—

". . . . . I rode in the ship.
It was the enemy!—The shoe was placed upon his foot, and he descended to my sanctuary—
It was the enemy!—He laid his unclean hands upon me,
He laid his hands upon me, and he drove me forth.
It was the enemy!—He laid his hands upon me, and made me bow down in fear
I was in trouble, and as for him, he feared me not—
He tore my clothes off fro n me and clothed therewith his wife.
It was the enemy!—He plucked off from me my lapis-stone, and gave it to his daughter.
I will make desolate his domain!
[As for?] myself, I will seek (desert†) places.
[In] my [refuge] he has worried me, he has disturbed me in my enclosed place."

Column III.

"Like a lonely (?) dove I rest upon a beam—
Like a wounded (?) *sudinnu*-bird I perch in a hollow place.
He frighteneth me like a bird in my house—
He frighteneth me like a bird in my city.
My house behind me constantly repeateth (that)
'I am the lady'—My city behind me constantly repeateth (the same).
I have said thus to my house: 'Thou art not my house'—
I have said thus to my city: 'Thou art not my city.'
'I will not enter it,' I said, 'for its magnificence will eat me up.'
'I will not ap[proach] it,' I said, 'for its lamentation will make me sad.'"

(The enemy then seems to say:—)

"Like the ground, thus hast thou destroyed it, thus hast thou ruined thyself‡—
Lady, thus hast thou destroyed thy sanctuary, thus hast thou ruined thyself
. . . . . [thou] hast given."

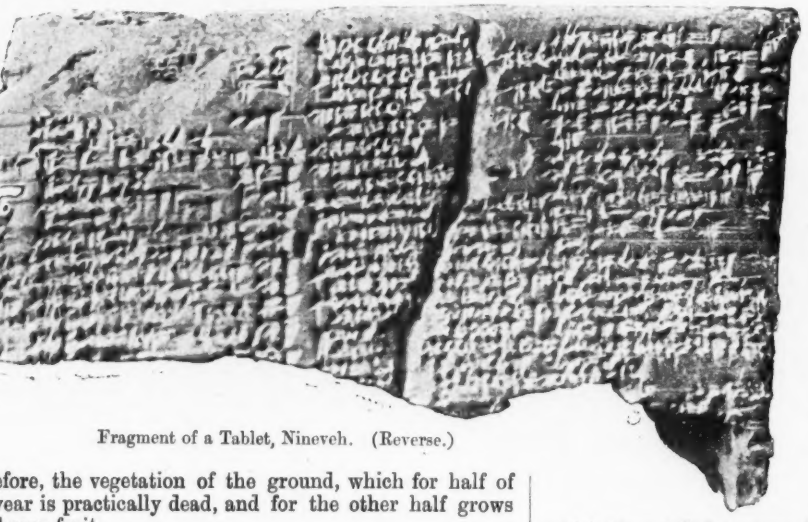
An extensive gap follows, and then we have some fragments of lines of column IV., in which the heroine asks: "Who hath driven forth the darling of mine eye? Who hath overthrown [my sanctuary]? I am [the honoured one?] of the god Bel; I am [the beloved?] of my father Sin; I am [the handmaid?] of the god Ea. [My lord] hath taken away, my king hath taken away . . . . . he hath caused to be taken away . . . . . I will

* "Brother" and "sister" seem to have been given as terms of endearment even to such as were not of that relationship. Thus a father would call his son *Akhia*, "My brother," and the name *Akhat-abi-sa*, "Her father's sister," is also found.

† Perhaps, however, "(holy) places" are meant.

‡ *I.e.*: "Level with the ground, thus hast thou destroyed it, and in like wise hast thou ruined thyself," &c.

give . . . . I will have it made . . . . . I will have it made firm . . . . ."



Fragment of a Tablet, Nineveh. (Reverse.)

is the ideograph for Istar as Delebat or Dilibat (the planet Venus), transcribed Delephat or Belebatos by the Greeks.

Such is the legend of the Lamentation of the Daughter of the god Sin, when her beloved was taken away from her, and she herself was stricken, driven forth, stripped naked, and reproached in her trouble—she, the honoured one of the gods, the beloved of her father Sin.

These two legends, or versions of a legend, present to us at first hand what the Babylonians of the oldest times believed concerning the myth of Adonis and Aphrodite. Many will probably remember the Greek story—how the young husband of that goddess went hunting, and was killed by the tusk of a wild boar, the type of winter. Aphrodite or Venus could not, however, give up her beloved, with whom the goddess of the infernal regions, Persephone, had also fallen in love, and would not let him go forth again from her realms. It was, therefore, decided that he should spend six months in the lower regions, and six on earth* with his beloved Aphrodite. Adonis typified, therefore, the vegetation of the ground, which for half of the year is practically dead, and for the other half grows and bears fruit.

is one of the usual monograms for Istar or Venus.

As has been already mentioned, Istar is the same as Venus or Aphrodite, and Tammuz, her beloved, is Adonis, "the fair son." The enemy, who carried him off, who spoiled the land, and who did not even spare the goddess herself, is death personified. The voyage of the goddess in a ship seemingly typifies the crossing of the river of death. The enemy, who, like the "porter of the waters" in the "Descent of Istar," took away all her garments and the jewel which she prized, is a type of "the king of terrors," for when we accompany him we must leave all behind, even that which we prize the most.

The reproaches which seem to be addressed to the goddess in column III. of the bilingual version, where it is said that it is she who has destroyed her home and sanctuary, and ruined herself, are hard to understand, unless we suppose that the ancient world regarded the misfortunes of the goddess as the well-merited punishment for her many sins, as told in the story of her love-making to the hero Gilgames. It was apparently recognized, even in those remote ages, that the goddess of love had much to answer for.

The lamentations for Tammuz were one of the principal features of his worship. At Byblos, or Gebal, in Syria, and elsewhere, a yearly festival, which was held by the women, took place, when the river ran red with the soil washed down from Lebanon by the autumn rains. This red colour of the water was said to be caused by the blood of the slain Adonis, whom the women then set out to seek, and a figure having been found which they regarded as his body, funeral rites were performed as wild, it is said, in their nature as the rejoicings at his resurrection were licentious. The following translations will give an idea of the lamentations for Tammuz used in Babylonia and Assyria:—

"Gubba, en, Dumuzi.

"Shepherd, lord, Tammuz, husband of Istar,
Lord of Hades, lord of the shepherd's abode;
Seed which in the furrow has not drunk the water,
Its stalk in the desert has not brought forth flower;
Branch which in its bed has not been planted,
Branch whose root has been removed;
Grain which in the furrow has not drunk the water." . . .
. . . . . .
(The remainder wanting.)

"Al-di, Gadan-gin, Gurusamen.

"Arise, and go, O hero, the road of no-return.
. . . . . .
Go, go, to the bosom of the earth!
He is revealed, revealed, to the land of the dead—
To those filled with grief—on the day he fell and was in distress,
In an unlucky month of his year!
To the road of the end of man—
To the rising-(place?) of the lord—
O Hero (thou wentest) to the remote land which is not seen."

The first quotation, which is incomplete, seems to be a poetical description of Tammuz, who was a shepherd, and the husband of Istar. Having been stricken down in the bloom of his youth, he is likened to plants and seeds which have failed to come to maturity from some accident of their existence. This simile was probably suggested by the fact that he was god of vegetation. The second quotation is a lament that he has gone down to Hades, and is rather difficult to translate here and there, as even the Semitic Babylonian scribe has found.†

The following incantation for purification speaks also of Dumuzi, or Tammuz, as "the shepherd," and mentions his "pure fold." It is interesting as showing another phase of the veneration of this god:—

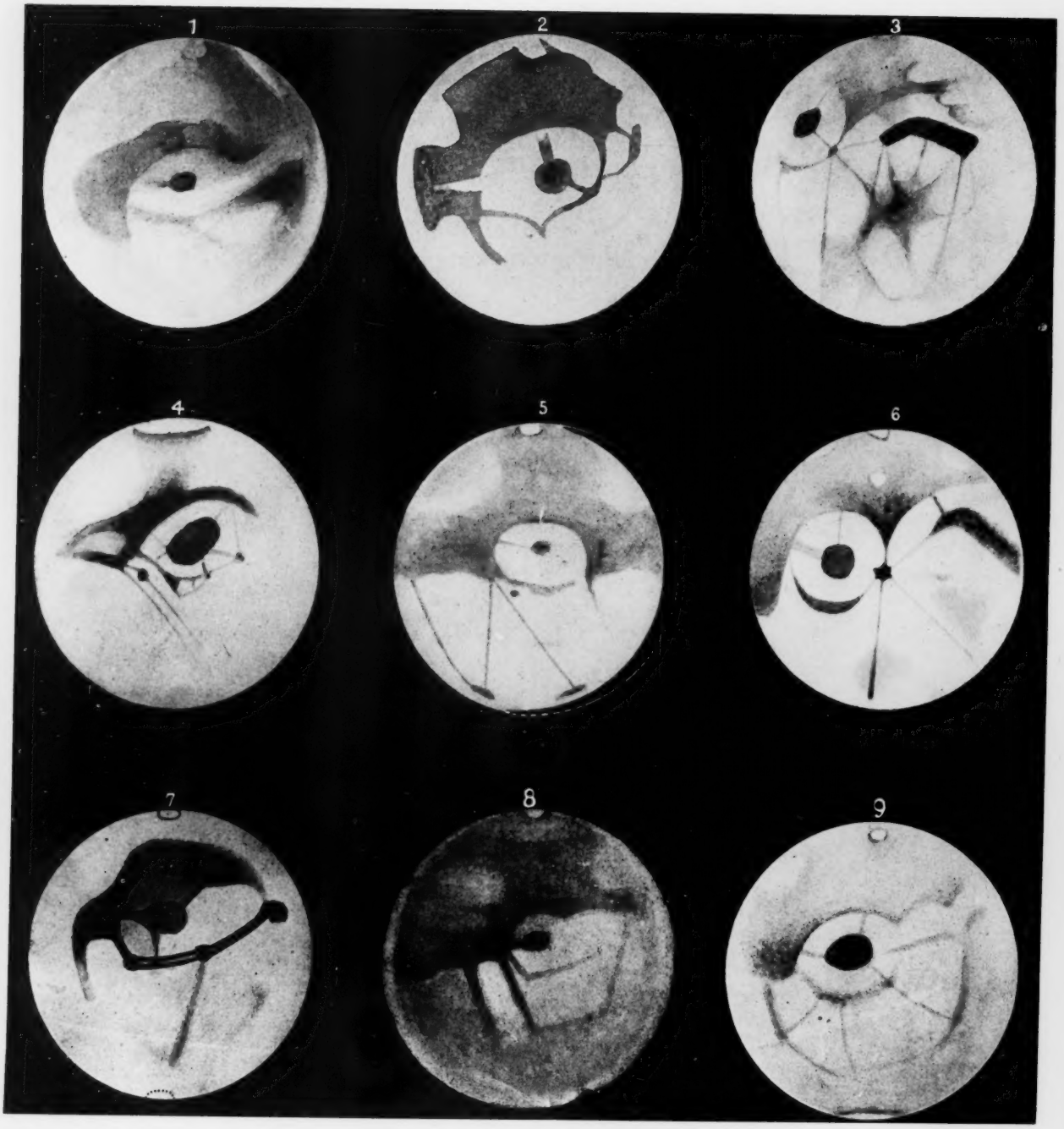
"En: Ga-uz-sigsigga.

"Incantation: The milk of a yellow goat which has been brought forth in the pure fold of the shepherd Tammuz—
Let him give thee the milk of the shepherd's goat with his pure hands
Mix it within the skin of a suckling shegoat undefiled—
Let Azaga-su give (him) to drink the sublime goat-milk of Bel with his pure hands.
Merodach, the child of the city Eridu, has given the incantation—
Nin-akha-kuddu, the mistress of the sparkling water, will purify him and make him clean.

(The above is) the charm of the milk of the yellow goat, and the food in the un[defiled] suckling's skin.

* Another account divides the year of Adonis into three periods of four months, one to be spent with Aphrodite, one with Persephone, and the third to be at his own disposal.

† These old Akkadian (or Sumerian) inscriptions were apparently translated into Semitic Babylonian (Assyrian) at a comparatively late date.



THE "EYE" OF MARS.

1.—Kaiser, 1862, October 24th.
2.—Schiaparelli, 1877, September 26th.
3.—Schiaparelli, 1879, November 11th.
4.—Hussey, 1892, August 17th.
5.—Guiot, 1892, September 6th.
6.—Brenner, 1894, September 14th.
7.—Williams, 1894, September 23rd.
8.—Cammell, 1894, September 27th.
9.—Antoniadi, 1894, November 1st.

Direct Photo Engraving Co., 9, Barnsbury Park, N.

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The name of Tammuz occurs also in other incantations, in one of which he is called En-mirsi, from which it may be surmised that he was patron-god of Lagash, an ancient city upon the Shatt-al-Hai, at present known as Tell-loh, from which site M. de Sarzec obtained many fine and very remarkable sculptures, now in the Louvre. One of the (bilingual) lists of gods mentions a deity called "Tammuz of the Abyss," with the explanation that he was one of the six sons of Ea, the god of seas, rivers, and of unfathomable wisdom. Taking this in connection with the first extract from the lamentations for Tammuz (quoted above), where he is called "lord of Hades," it would seem that he was really regarded as the consort of the queen of that region during his yearly six months' stay in "the land of the dead."

Manners and customs have changed much in "the changeless East" since the legend and lamentations for Tammuz, translated above, were written.* The spread of Christianity and Mohammedanism was the death-blow to all the legends of the ancient gods—they live again only by the resurrection of the ancient literature of Babylonia and Assyria. Women no longer seek the body of "the faithful son," near Gebal, and lament his untimely death; and the temple of Yahwah at Jerusalem, in which holy place Hebrew women of old imitated their sisters of Syria, exists no longer. The land of Akkad, where the legends, lamentations and incantations referring to Tammuz seem to have had their origin, is no more; and the two towers of Agadé, its capital, which were dedicated to Tammuz, probably fell into ruin years before the Christian era. With regard to the beautiful Sumerian legend of the lament of the daughter of the Moon-god, whose disrespectful enemy, with "the shoe on his foot," despoiled her of all she liked best, we must wait for the completion of the text from the ruins of Nineveh; and perhaps the cities of Babylonia may yield treasures in the shape of duplicates that will fill the gaps. Even though this, however, should never take place, the preservation of the fragment now translated is, even in its present incomplete state, a thing to rejoice over.

* Probably before the date of Sargon of Agadé—that is to say, earlier than 3800 years before Christ.

THE "EYE" OF MARS.

By E. Walter Maunder, F.R.A.S.

ONE of the most interesting and most easily recognizable markings of Mars is the nearly circular spot which, in the earlier days of the study of the planet, was known as the "Oculus." A more suitable name could not well have been chosen for it, for the dark spot lies in the centre of a slightly elliptical bright district, and above this to the south another dark district forms an admirable eyebrow. The name, has, however, dropped out of use, having been superseded by the various names adopted by successive areographers. Thus, Proctor in his chart of 1867 calls it "Lockyer Sea"; Green in his map of 1877 calls it "Terby Sea"; and Schiaparelli has given it the name of the "Lacus Solis." Yet surely the earlier name was not only appropriate to the appearance of the marking itself, but suited well with the mythological and astrological traditions attaching to the planet. If the ruddy hue suggested the fierceness and valour of the god of war, the ever-open eye would be no bad symbol of the vigilance which, next to courage itself, should be the characteristic of the soldier.

It is, however, not worth while complaining of the loss of the more poetic name. It would have been hard to have constructed an entire nomenclature for the planet on accordant lines, and in view of the vast array of detail which Schiaparelli has brought under our notice, and of the necessity for *some* system of names, we may well gratefully accept Schiaparelli's, even if it be a trifle bizarre.

The "Lake of the Sun" then—the "Eye" of Mars—is a nearly circular dark spot, some 17° of areographical longitude in its greatest length, by about 14° of areographical latitude in its greatest breadth, say 560 miles by 510 miles. Thaumasia, the bright district in the centre of which it is placed, is nearly 1200 miles in diameter. In actual area, therefore, the Lake of the Sun is nearly twice as large as the Black Sea, whilst Thaumasia is about as large as Arabia.

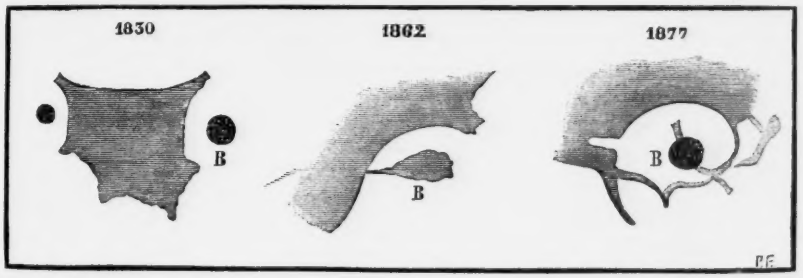

Fig. 1.—The "Eye" of Mars, as drawn in 1830, 1862, and 1877. From Flammarion's "Mars," p. 323.

It is very necessary for us to bear these dimensions in our minds, for we are otherwise apt to lose the true significance of what we observe on our planetary neighbour. The average diameter of the Lake of the Sun when Mars is at opposition is just 2″ of arc; in a favourable opposition, when the southern pole of the planet is turned towards the earth, and we therefore see the lake to best advantage, its diameter is $2\frac{1}{2}''$.

Usually, then, it is seen as a dot—a dot sufficiently large to be seen as such with quite a small instrument and a low power, but a dot that requires unusually good conditions and a high power to give much information as to the details of its structure.

We see it in its simplest form in the left-hand drawing of Fig. 1, which, like the woodcuts which follow, is reproduced from M. Flammarion's superb monograph, "La Planète Mars." This drawing forms part of one made by Beer and Mädler on October 13th, 1830, in the course of that study of the planet which enabled them to produce the first chart of Mars. The telescope they employed had an aperture of four inches.

In the year 1862 Mars was again very favourably placed, and Kaiser, at Leyden, made a second chart of the planet. The first figure in our plate represents his drawing of this region as made on October 24th of that year. This opposition was also signalized by a fine series of drawings by Lockyer, published in Vol. XXXII. of the *Memoirs of the Royal Astronomical Society*, both Kaiser's and Lockyer's drawings showing a great advance in detail over Beer and Mädler's, the later observers being armed with six-inch telescopes. Lassell, Phillips, Secchi, and others were also at work during this opposition, whilst the next opposition, that of 1864, supplies us with the drawings of another

first-class observer, the Rev. W. R. Dawes. From these designs we gather some further details. The Lake of the Sun is no longer simply a circular dot. It is elongated, and occasionally irregular in form; and alike in the drawings of Kaiser, Lockyer, and Dawes, we meet with a new feature, now so familiar to us under the name of "canal," a narrow line linking the Oculus to the outer sea towards the east.

It is, indeed, as the focus of a "canal" system of its own that the Lake of the Sun has much of its importance to us. Mars is dotted over with "lakes" from which "canals" appear to radiate, but none of them have the importance of the Lake of the Sun. In other cases it is a question whether the "lake" is due to the "canals," or the "canals" to the "lake." In this case the primary importance of the "lake" is manifest.

There is no need to refer to the less favourable oppositions, for not only was Mars then further from us, but the district we are considering was presented under a more or less foreshortened aspect. But in 1877 we had again a very favourable opposition, and a great number of observers were at work on the planet—Green and Schiaparelli in particular. The drawings of the former,

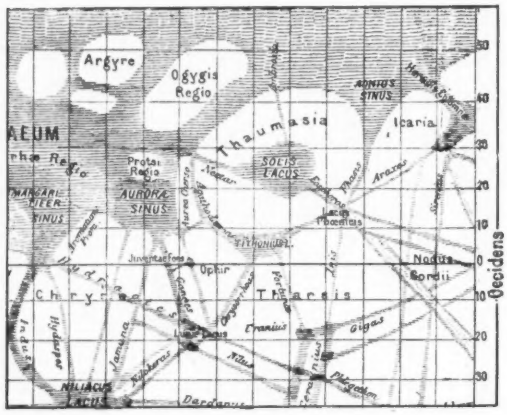

Fig. 2.—Key-map of the Lacus Solis region, according to Schiaparelli. From Flammarion's "Mars," p. 361.

published in Vol. XLIV. of *Memoirs of the Royal Astronomical Society*, still remain the most truthful and life-like pictures of Mars that have yet been published, though later observers have added many details which escaped even Mr. Green's great powers of sight. The second figure in our plate is by Schiaparelli, under date September 26th, 1877. The third is also by the same observer, and was made at the next opposition, on November 11th, 1879, when Mars was again suitably presented for the study of this region, and when the "canal" system had undergone, as the sketch unmistakably shows, a most extraordinary development.

During the next two or three oppositions the chief work on Mars was effected by the industry of the great Italian astronomer, and he brought out chart after chart, each showing a distinct advance on its predecessor, and each depending on a fine series of careful micrometric measures for the positions of the principal points. It is beyond all doubt due to the fact that they are based on *measures*, not on eye estimations only, and that as one of the best living double star observers, Schiaparelli was a past master in the use of the micrometer, that his charts of the entire planet are confessedly the best that have yet been published. Nor is this fact in any way contradictory of the criticisms that have been passed on certain of his drawings of individual portions.

In Fig. 2 we have a portion of his chart of Mars, published as the result of nine years' work, and showing the region with which we are more particularly concerned. In Fig. 3 we have a drawing made by him of Thaumasia on June 9th, 1890.

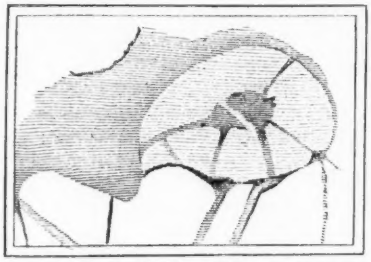

Fig. 3.—The "Eye" of Mars, as drawn by Schiaparelli, June 9th, 1890. From Flammarion's "Mars," p. 573.

Here a new detail is shown. Beside the numerous canals radiating off from the Lake of the Sun in all directions, the lake itself is crossed by a "bridge" some 500 miles long and, perhaps, 50 wide.

We now come to the last two oppositions. The former of these is illustrated in our plate by two strongly contrasted pictures; Nos. 4 and 5—the former by Mr. Hussey, drawn on August 17th, 1892, with the aid of the great thirty-six inch refractor of the Lick Observatory; the latter by M. Guiot, on September 6th, 1892, with the nine-inch telescope of M. Flammarion's observatory at Juvisy. No. 4 was published in *Astronomy and Astro-Physics* for October, 1892; No. 5 in *L'Astronomie* for November, 1892. The four remaining designs represent the oppositions just past, and I am indebted for them to the kindness of the respective artists. They were taken as follows:—

No. 6 by Herr L. Brenner, Manora, Istria, on September 14th, 1894.

No. 7 by Mr. Stanley Williams, Brighton, on September 23rd, 1894.

No. 8 by Mr. Bernard Cammell, Wokingham, on September 27th, 1894.

No. 9 by M. E. M. Antoniadi, Paris, on November 1st, 1894.

The most casual glance at the nine drawings given in the plate shows that, whilst it is absolutely clear that all the observers were watching the same district of the planet, and though all agree in certain broad features, the differences in detail are neither few nor slight.

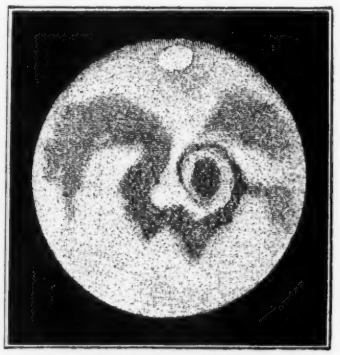

Fig. 4.—The "Eye" of Mars, as drawn by Secchi, October 18th, 1862, at 7h. 24m., Greenwich Mean Time. From Flammarion's "Mars," p. 549.

Do these differences represent real facts, or are they simply due to imperfect seeing and imperfect drawing? That much of the diversity in sketches of Mars rests with the observer, and with him entirely, has often been shown, and in particular by M. Flammarion in his classical work. One of the instances which he adduces of manifest "personal equation" relates to this very district of Thaumasia. Father Secchi made a drawing of Mars at

Rome on October 18th, 1862, at 7h. 24m., Greenwich time, whilst just 36 minutes later Lockyer completed another drawing in London. The two astronomers were, therefore, probably actually observing the planet for some little

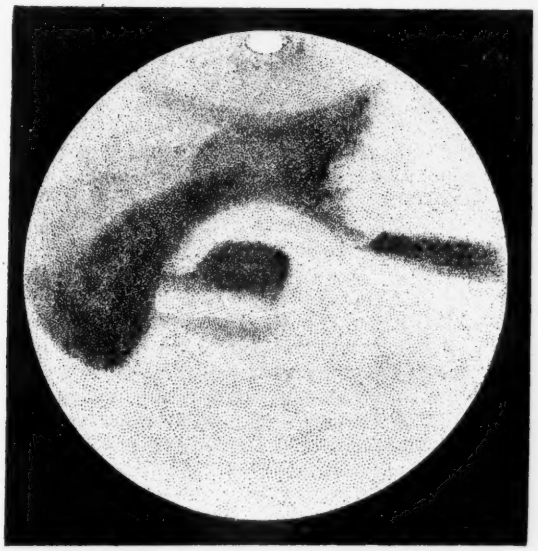

Fig. 5.—The "Eye" of Mars, as drawn by Lockyer, October 18th, 1862, at 8h. 0m., Greenwich Mean Time. From Flammarion's "Mars," p. 549.

time together, for the Italian may very well have continued to watch it after the completion of his sketch, whilst the Englishman must certainly have commenced his watch some appreciable time before that recorded for the completion of his design. On the whole, the latter must be accepted as by far the more accurate. Kaiser's drawing of six days later (Fig. 1 of the plate) is in too close accord with it for there to be any doubt as to its substantial accuracy. It follows, then, that we must accept it as established that an astronomer, even of such eminence as Secchi, could make most serious errors in his representation of one of the leading features of the planet. The spiral "canal" that sweeps round the Lake of the Sun, and finally into it, is clearly due to some confusion with the outer coast of Thaumasia—the similarity of shape of neighbouring outlines on Mars is one of the most fruitful causes of errors in drawings of it; the heavy W to the north of the lake is a manifest exaggeration of the Lacus Tithonius, seen so faintly on Lockyer's drawing. Lockyer, on the other hand, probably under-estimated this latter marking, and failed to detect any trace of the estuaries of the Chrysorrhoas and Fortuna, where they open into the Lacus Tithonius, to which no doubt the lower points of Secchi's W correspond.

But even discrepancies like these are not sufficient to overthrow the evidence for real change that exists. Compare the two little sketches given below; Fig. 6, from a drawing by Dawes, under date January 21st, 1865, and Fig. 7, from one by Green, of September 29th, 1877.

In the earlier drawing, the two lakes, Solis and Tithonius, are shown as "bottle-necked" seas, to use Proctor's term. Both are connected with the Mare Erythræum by "canals," and of the two Tithonius is the larger and darker. In the later, Solis is completely cut off from the Erythræan Sea, but is joined by a short canal, the Eosphorus, with the little Lacus Phœnicis. Other drawings of Mars made by Dawes on November 3rd. 10th and 12th, 1864 (see *R.A.S. Monthly Notices*, Vol. XXV.), show Tithonius as most distinctly larger than Solis, and like it in shape, and all agree in showing the Nectar canal to the east of the Lake of the Sun, whilst of the Eosphorus and the Lacus Phœnicis on the west there is no trace. On the other hand, Schiaparelli (Fig. 2 of the plate) fully confirms Green with respect to the Eosphorus and Lacus Phœnicis in 1877; so do my own drawings made at the same opposition. Schiaparelli, indeed, shows Tithonius as a narrow, winding canal on September 26th, whilst Green gives no trace of it three days later. But this was probably no mere oversight, but due to a real disappearance, since on September 2nd he had shown it as a faint streak. So it appeared to myself at about the same time, and so to Flammarion, Dreyer and others, whilst not a few good observers, Terby amongst them, failed to detect it at all. It is quite clear that there was a complete change, therefore, in the intensity and definiteness of Tithonius between the oppositions of 1864 and 1877. Although as large and as dark as the Lake of the Sun in the former year, it was scarcely perceptible in the latter, and would indeed appear to have faded entirely away by the date of Mr. Green's last observation.

One difference which the nine drawings in the plate bring out is manifestly due to the artist; the difference in the *scale* of certain of the markings. This is a point which every comparison of a number of drawings by different hands is sure to bring out. The cause of it is obvious. The observer has first to study the planet at the telescope, to patiently trace out the different details, and then depict them, more or less *from memory*, in his sketch. The drawing cannot be made at the very instant that the original is being viewed. The degree, therefore, to which some point attracts special attention will have much to do with the relative proportion given to it. Individual discordances are often considerable, and "changes on Mars" have been advertised in the most reckless fashion, on the faith of a single drawing, quite neglectful of this source of error even with the best artists.

Yet the evidence for an actual change, both in the size and in the intensity of the Lacus Solis, as instanced in Figs. 4 and 5 of the plate, is very considerable. Mr. Stanley Williams, for instance, like M. Guiot, found the lake both small and faint during September, 1892.

The case is clearer when we come to the *forms* of the

Fig. 6.—Mars, by Dawes, January 21st, 1865.

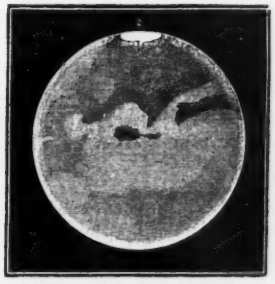

Fig. 7.—Mars, by Green, September 29th, 1877.

markings. Thus drawings 2, 3, and 6 in the plate show the western edge of Thaumasia under a very different aspect to drawings 7, 8, and 9. The former three show the Sinus Aonius most accordantly; the latter three show no trace of it. This evidence is further supplemented by that of Mr. Lowell, at the Flagstaff Observatory, Arizona.

XUM

To him and to Prof. Schaeberle a bright fan-shaped marking covered the site of this gulf throughout August, 1894. Herr Leo Brenner, it will be seen, saw it under its accustomed form on September 14th, whilst on September 23rd Mr. Stanley Williams found it again covered, and Mr. Cammell confirmed the observation four days later. The obscuration then, whatever its cause, had cleared off in the fortnight between August 31st and September 14th, and had taken shape again nine days later.

No. 5 shows a more extraordinary change still, but in the other direction. Here M. Guiot records that the Aonic Gulf has submerged the whole of Icaria, so that the Mare Sirenum and the Sinus Aonius have become merged into one. This effect has often been represented, and particularly in 1892. The difficulty of explaining it arises from the fact that one observer will show Icaria in its proper form and place, but a little while before or after another observer fails to see it at all. Nor is Icaria the only district on Mars which has this faculty of vanishing. Compare Schiaparelli's drawing made September 26th, 1877 (Fig. 2 of the plate), with Mr. Green's drawing made three days later, and note how the bright spike, Protei Regio, which juts out from Thaumasia towards the east on the former, is represented by a more diffused marking on the latter. This region, well named Proteus, was seen by Dawes in 1864, and was often observed in 1892, amongst others by Stanley Williams and Keeler, and always as of about the same size and in nearly the same place, though the shape is apt to change a little. Most drawings, however, fail to show it.

There are in all some six or eight such areas on Mars, which may be seen or not seen, apparently almost at random. Either, then, these are districts which impress differently the eyes of different observers, or they change their appearance with great rapidity.

It is easy to explain the disappearance of a *dark* marking, even when it takes place in the course of a few minutes. The formation of mist or cloud may readily hide a sea from us. During the opposition of 1894, for instance, the Maraldi Sea (Mare Sirenum and Mare Cimmerium), and the whole region to the north, were completely hidden for several days. But the temporary disappearance of a district usually *bright* is a harder matter to account for. We can scarcely imagine that cloud masses habitually cover certain water areas, preserving a definite and stable outline above them, and then become dissipated for a while, soon to reappear and to resume the old forms.

Some changes appear to be manifest surface-changes, and not mere meteorological effects. And here Thaumasia, standing out as it does considerably nearer the pole than the bulk of the land mass of Mars, is an object of special interest. The observations of Lowell, made during the opposition just past, confirming and completing similar observations of other astronomers in former years, show that when the long winter of the southern hemisphere has come to an end, the polar cap shrinks with great rapidity, and becomes ringed with a dark belt, evidently the water from the melted snows. This area broadens and spreads, and the "canals" begin to appear. In June, 1894, midway between the spring equinox and summer solstice for the southern hemisphere of Mars, the "canals" were generally few and faint, and it was in Thaumasia and the neighbourhood, where the great wave from the melting of the polar snow might be expected first to break, that they first showed up dark. The solstice fell on August 31st, and the "canals" continued to be dark throughout September; afterwards they began to pale.

The three chief "canals" entering the Lake of the Sun are the Ambrosia on the south, the Nectar on the east, the Eosphorus on the west. Of these the Nectar was seen in many comparatively early observations. Thus, as already pointed out, Kaiser and Lockyer saw it in 1862 and Dawes in 1864, a broad sheet of water about the length and breadth of the Adriatic. But in 1877 it was not seen, whilst the Eosphorus was. The Ambrosia, again, has likewise been seen, by itself and in company with one or both of the other two.

This circumstance renders it difficult to suppose, as one otherwise might, that when the Erythræan Sea rose above a certain level it flowed by these three "canals" into the Lake of the Sun, or that when the Lake of the Sun attained a certain level it overflowed by these three channels into the sea. For if one "canal" were full, all three should be. We are driven to suppose, then, the surface of Thaumasia to be exceedingly flat, so that a very trifling change may block one channel or open another. And seeing the apparent scale of these "canals," as long, and often as wide, as the Adriatic, does it not seem probable that each one of them, even the narrowest, is really made up of many narrower channels, winding and turning after the manner of terrestrial rivers, and only seen as straight, because what is seen by us is only the summation of a complexity of detail, far too minute to be ever separately discerned? The striking difference in tint between the southern and northern halves of Thaumasia, shown by Kaiser in Fig. 1 and confirmed in Fig. 7, may well be due to a vast network of such minute canals in the former district.

Each optical improvement, each improvement in the location of our telescopes, the continual improvement by practice of observers, all uniformly tend to make the "canal" system more complicated. Compare Mädler's circular spot with no canals in 1830, Kaiser and Lockyer's one canal in 1862, the two canals of Schiaparelli in 1877, the three he saw radiating from the Lake of the Sun in 1879, the four M. Antoniadi shows, the five Mr. Hussey saw at Lick, with the nine Mr. Douglass drew at the Lowell Observatory last October, and has figured in his sketch in *Astronomy and Astro-Physics* for November.

A very level surface intersected by shallow channels, most of them probably too narrow to be separately defined by any telescopic power we possess, is, then, the probable explanation of the changes of Thaumasia, and if of Thaumasia, no doubt of most of the land surface of Mars. The changes in the size of the Lake of the Sun probably show that the inner coast of Thaumasia, as one would expect from so flat a country, shelves down into the lake very gradually; and this again may be taken as typical of most Martial seas. The changes in Icaria, in the Aonic Gulf, and in the region of Proteus seem to require, either that these districts have some quality which causes cloud to form above them more readily than is the case with neighbouring districts, or else some property which renders the amount of cloud, which elsewhere would pass unnoticed, readily visible when it does so form. The former we might explain as indicating regions where warm moisture-laden winds from the equator meet cold winds from the pole; but the regions seem too sharply limited for this to be the case, and, as I have shown elsewhere, the meteorological circulation of Mars is necessarily very languid. To my own mind it seems more probable that throughout the planet in general the difference of level between land and sea-bed is but slight, and the gradients very gentle, so that the difference in the sea-level, consequent on the melting of the winter snows, has a vast effect on the extent of the area submerged. Probably, too, these are regions either where the land is full of broad shallow lakes, or the sea full of flat islands or slightly sunken shoals; details too small

to be individually discerned, but producing in the aggregate a certain definite effect. The formation or dissipation of an amount of light cirrus cloud, which elsewhere would be unnoticed, might easily, over regions like these, change what appeared to be sea into what looked like land, and *vice versâ*, and this in a few minutes of time. Indeed, since eyes are differently sensitive to delicate differences of shade, the same region at the same instant might appear to one observer as land, to another as sea. Except on some such principle as this, it seems hard indeed to account for the repetition, at long intervals of time, of changes of light regions to dark and dark to light, not indiscriminately all over the planet, but in certain comparatively small areas of well-known and definite outline.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

To the Editor of KNOWLEDGE.

SIR,—In an article called "Stars and Lights," by the Rev. Charles Pritchard, in *Good Words* for May, 1869, the writer states that Herschel, observing the star Mira, found that it reached its greatest lustre on November 2nd, 1779, and on October 21st, 1790. He goes on to say that the interval between these two dates gives eleven periods of 331 days, but that interval exceeds the stated periods by 365 days. The year 1790 being three times mentioned in connection with the latter observation, a student would not feel justified in correcting to 1789, while a correction of the former observation date to 1780, a leap-year, would still throw the calculation out to the extent of one day.

Could you kindly say whether 1789 should be substituted for 1790?

Yours faithfully,

Maisonette, Wallington. THOMAS HENCHMAN.

[The late Prof. Pritchard was a very accurate writer, but even accurate writers occasionally make mistakes; moreover, it is always difficult to be secure against printers' errors in a popular periodical.

In the present case it is evident that Prof. Pritchard wrote, or intended to write, twelve (not eleven) periods between the maxima of 1779 and 1790. W. Herschel's observation of the former is interesting as being given in the first paper he ever sent to the Royal Society, which was communicated by Dr. Watson of Bath, and read on May 11th, 1780. It will be noticed that he does not fix the exact day of the maximum in the preceding year, but says that on November 2nd the star's lustre was "still increasing"; on November 20th it was "as bright as before, but no brighter"; and on November 30th it had "considerably decreased." In the account given amongst his "Miscellaneous Observations" (read on December 22nd, 1791), he says that he takes the epoch of October 21st, 1790, as "one of the best ascertained moderate appearances" he could obtain, and that he believes it to be "more proper for settling the period than that which might be deduced from a brilliant blaze of the star, such as took place in 1779, owing to causes that are not regular, and therefore may be apprehended to disturb the general order of the change." Sir William deduced what he thought the most likely period from the observation of a maximum by Fabricius, August 13th, 1596, and this of October 21st, 1790, contending that its length was 331 days 10 hours 19 minutes, though others had made it as much as 334 days. Sir John Herschel, we may add, puts the average period at 331 days 8 hours 4 minutes; but it is undoubtedly subject to some amount of irregularity. W. T. L.

Blackheath.

ON THE ELECTRIC ORIGIN OF THE SOLAR CHROMOSPHERE.

To the Editor of KNOWLEDGE.

DEAR SIR,—As you have kindly communicated to me Mr. Evershed's answer to my former letter, I now send you some further remarks.

1st. *Sodium vapour.*—The conclusions adopted by Mr. Evershed, after his last explanations, appear to be more probable; but, though the experiments related have a great value, his proofs, in my opinion, are not complete.

Mr. Evershed relies on the difference in the width which the yellow D line shows in the heated tube and in the flame; but is not the greater width in the tube due simply to the greater proportion of sodium, which is slowly distilling from a hot to a cold part of the tube, whereas in the flame it is rapidly drawn out?

Mr. Evershed supposes that hydrogen gas has no influence on the production of the characteristic line D; how then can he explain the familiar experiment of Prof. Lockyer on sodium when heated and electrically illuminated in a vacuum tube? (*Proceedings of the Royal Society*, 1879, p. 140): "Hydrogen is given off in large quantities, and at the end the vapour shows the red and green lines, without any trace whatever of the yellow one."

These questions are very difficult and complex, even with the apparently simple case of sodium. For my part, I think it is almost impossible to decide, at very high temperatures, that no chemical combinations or allotropic changes are taking place.

2nd. *Hydrogen.—Application to the solar chromosphere.*—The experiments on sodium are not sufficient for application to the case of the solar chromosphere, because sodium is not the only constituent of the latter; hydrogen gas, which is much more imporant than sodium in the sun, and which exists also in the stars and nebulæ, should be also examined. As yet, however, it has not been found to give its characteristic lines by heat or by chemical combination after a great many experiments under different conditions—an electric interference is necessary; so that we may conclude that the chromosphere is an electric flame.

Some observers, including Prof. Tacchini and Dr. Huggins, have also set forward the same opinion or conclusion, but on other grounds. Dr. Huggins, in his Bakerian lecture in 1889, concludes from a general and remarkably able study of the solar corona that the phenomenon is electrical, and, extending this result, he adds, "We can scarcely doubt that electric disturbances of exceptional magnitude accompany the formation of the prominences; indeed, these phenomena may themselves be, in part at least, electric discharges analogous to terrestrial auroræ."

From all points of view, then, an electric origin is, in the actual state of our knowledge, decidedly the most probable. Moreover, the new photographic method, which reveals the chromosphere on every point of the solar disc, has permitted us to take a further step, and to compare exactly the electric states of terrestrial and solar atmospheres. Now the distribution of electricity appears exactly the same in the two bodies, and I wrote in 1893 (*Comptes rendus de l'Académie des Sciences de Paris*): "The phenomena of solar chromosphere and terrestrial atmos-

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pheric electricity are similar, and their simultaneous study will be useful to both."*

Against this general view Mr. Evershed argues that it necessitates on the sun a continuous discharge of electricity over the whole sphere, and that on the earth the difference of potential does not imply a necessarily similar discharge. The objection is only an apparent one, and rests on the use of the word "discharge," which is not appropriate in the case of the earth; for in our air, which is imperfectly isolating, we have simply in the ordinary case a continuous outflow of electricity in the vertical direction; a greater difference of potential being necessary to form a true discharge, as in the sun. The causes of the two phenomena are the same, and act continuously so as to maintain the ordinary state of things; they have only different intensities and effects.

Likewise, when a body has a relatively feeble charge of electricity, it loses its charge continuously and slowly in the air, without any sensible effect on our senses; it is the ordinary case of our atmospheric electricity. If the charge is greater, we can perceive in a dark room a feeble blue light around the body; and with a much greater potential the true discharge appears, attended by noise and strong light. This is the case of the sun, where the high temperature of the gases makes the discharge easier.

The analogy between the two atmospheres appears to me to be striking, and I have purposely refrained from seeking the exact cause which maintains the differences of potential, because it is not useful for the comparison.

3rd. *Application to the Stars and Nebulæ.*—This analogy can be extended up to a certain point to the other celestial bodies, for in the spectrum of the sun, examined as a star, the whole chromosphere is exactly represented by a feeble bright line in the middle of the broad black line of calcium. The sun, then, is a bright-line star, and may be grouped with the variable stars, temporary stars, and nebulæ. But the bright line of the sun is very feeble relatively to the continuous spectrum, whilst it is strong enough in variable and temporary stars, where it was first discovered, and in nebulæ it is very strong indeed. On the other hand, the line is reversed in the sun, but certainly has not the same character in all the other bright-line stars, as Father Sidgreaves has already noticed with the variable star β Lyræ. I will examine only the case of the new star in Auriga, which was formed, at the beginning, by at least two bodies moving rapidly the one towards the other; then the bright lines of one of the bodies were very probably reversed lines, as recent studies on the corresponding line of the sun have shown; so that we are driven to see some connection between the atmospheric electricity of the earth and the singular case of the new star in Auriga. In fact, the phenomenon of the new star is due either to the rapid approach of two bodies or to a motion of matter, just as atmospheric electricity, likewise, has often been ascribed to the relative motions of the higher parts of our atmosphere. Perhaps it may be possible to explain by some general cause, very probably electrical also, all the gaseous lights of the heavens—meteors, comets, the luminous atmospheres of stars with their periodic variations, and nebulæ.

Faithfully yours,

Paris Observatory. H. Deslandres.

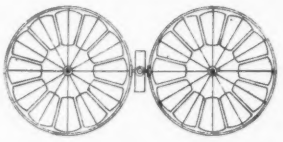
* If we extend the analogy, we are driven to suppose in the atmosphere of the earth a phenomenon similar to the solar corona.

MECHANICAL FLIGHT.

To the Editor of Knowledge.

Sir,—One of the readers of Knowledge wishes to know how I obtained by experiment, in 1875, a lifting force of forty pounds per horse power, while Mr. Maxim only obtained a thrust of two thousand pounds with three hundred and twenty horse power, equal to only five and a half pounds per horse power. As the subject may be interesting to many of your readers, I venture to reply through your columns.

Not having been able to make a second travelling experiment with my machine, through its accidental damage by exposure to a heavy gale of wind, I fitted the engine with two horizontal screws, as shown in the diagram,



which is a plan view drawn to a scale of a sixteenth of an inch to the foot. The screws were twelve feet in diameter, arranged on each side of the engine and boiler. Twelve planes, each having an area of seven square feet, were mounted on each wheel. The hoops were formed of laminated pine, with wire spokes, like velocipede wheels. The planes were made of strong calico, mounted on bamboo canes, and, when driven at full speed, the planes bellied to some extent, thus acting as screw blades with increasing pitch.

The screws were driven at sixty-seven revolutions per minute, which would impart a speed of the effective diameter of over twenty-three miles an hour.

It would scarcely surprise anyone if a plane of one hundred and sixty-eight square feet, driven in a straight line at twenty-three miles an hour, were to sustain one hundred and twenty pounds. Therefore it is not surprising to me that fifty-six square feet to each horse power should sustain forty pounds in my experiment. As it was made twenty years ago, I cannot now remember the pitch of the screws.

Mr. Maxim's screws are seventeen feet ten inches in diameter, and five feet wide at their ends. If these screws were fitted to vertical axles, and not allowed to rise beyond a few inches, as in my experiment, the effective surface would be only thirty-six square inches to each horse power. The difference is, therefore, in one case *thirty-six square inches*, and in the other *fifty-six square feet* to each horse power, and therefore my experiment naturally shows nearly eight times the thrust of Mr. Maxim's screws, per horse power. It is, however, necessary to bear in mind that Mr. Maxim's screws were travelling, while mine used the whole power in slip.

Not having any definite data as to the revolutions per minute of Mr. Maxim's screws, I therefore cannot carry the comparison further.

Yours truly,

8, Quality Court, W.C. Thomas Moy.
12th February, 1895.

THE INTELLIGENCE OF INSECTS IN RELATION TO FLOWERS.

By the Rev. Alex. S. Wilson, M.A., B.Sc.

Besides the attractions which they offer to insects, flowers are generally provided with the means of excluding certain classes of visitors. Diligent visitors, as a rule, are welcome, and indolent habits alone, as was shown in an article on the "Industry of Insects in relation to Flowers" in the December number of Knowledge, are sufficient to render a visitor undesirable. The value of any set of fertilizing agents depends on the number of separate flowers which each individual visits; multiplying the visitors does not,

therefore, compensate for their lack of diligence. The visit of a systematic worker is far more efficient than that of a less industrious insect; but this is due quite as much to intelligence as to diligence, for the careless or unintelligent can no more avoid entering the same flowers repeatedly than a number of separate insects working independently. Revisitation not only does a flower no good, but involves loss, its pollen being brought back and applied to its own stigma instead of being transferred to another blossom. Insects which return to flowers already visited lose their time. In their own interest, therefore, the more intelligent will avoid overlapping, and their efficiency as fertilizers will increase in proportion.

From the structure of the honeycomb, which affords a maximum of storage capacity with a minimum expenditure of wax and labour, we are prepared for a corresponding economy in the work of collecting honey. The methods adopted by the bee for the purpose of saving time are interesting and instructive in a high degree. Intelligent procedure is essential in view of the extremely small amount of nectar contained in most flowers. By chemical analysis the quantity of sugar present in any blossom can easily be ascertained. Some years ago I made a number of experiments which illustrate the arduous nature of the task performed by bees. The results showed that to obtain one grain of sugar a considerable number of flowers are requisite. Of the blossoms of the fuchsia $8\frac{1}{2}$, of the sweet pea $6\frac{1}{4}$, of the monk's-hood $10\frac{1}{10}$, and of the red clover $8\frac{1}{4}$ heads were respectively needed to furnish a single grain of sugar. Of smaller blossoms a much larger number was necessary. In the clover, which may be taken as a typical example, the head consists of about sixty florets, and we must, therefore, multiply the $8\frac{1}{4}$ by this number to find how many times the insect's proboscis must be inserted into a flower to obtain a grain of sugar. There are 7000 grains in a pound; this quantity, therefore, represents $8\frac{1}{4} \times 60 \times 7000$, or 3,465,000 separate flowers. Honey, however, only contains about seventy-five per cent. of sugar, so that in round numbers a pound of honey represents two and a half millions of clover tubes rifled by the bees!

It is evident from this illustration that industrious habits are indispensable to insects which depend on sugar as a source of sustenance, and it is not surprising that they should try to lighten their labours by economical methods. A more remarkable circumstance is that the arrangements in many flowers are specially adapted to turn these economical habits to advantage in promoting cross-fertilization.

The first of these methods of saving time worth mentioning was noticed by Aristotle, and may be observed by anyone who cares to follow the operations of a bee. A marked characteristic of the bee's method of working is, that in the course of a single journey the insect, as a rule, confines its visits to the flowers of one species of plant. The Lepidoptera and some of the Diptera also follow this method, though not, perhaps, so rigidly as bees. Mr. A. W. Bennet, who has paid some attention to the methodic habits of insects in visiting flowers, records three flights of the painted lady, in which the insect confined itself to the same species, settling six, three, and ten times respectively. A hive-bee paid nine successive visits to the same species of flower; one bumble-bee fifteen, and another eleven, passing over many other flowers. Mr. H. O. Forbes saw a bee visit thirty flowers of the dead nettle in succession, passing over other flowers, such as Convolvulus, Rubus and Solanum. This habit is very manifest, particularly in our native bees; when any plant is very abundant they may frequently be seen at work upon its blossoms almost continuously, for hours, if not for entire days. No doubt this is partly explained by the limited number of species whose flowers secrete nectar on any given day. A flower does not generally begin secreting until its essential organs are mature, since the need for economy presses upon the blossom as well as the bee. There can be no doubt, however, that Mr. Darwin's explanation is the true one. By keeping to one kind of flower at a time the insect gets familiar with its ins and outs, and can thus work more rapidly, while practice makes it expert, and thus time and labour are saved.

The importance of this habit to flowers is very obvious. An insect which visits all kinds of flowers indiscriminately misplaces the pollen, carrying it to the stigmas of a different species from that whence it was obtained. Constancy on the part of the visitor prevents the pollen being taken to the wrong flowers, where it would be quite wasted. Not only, therefore, must an insect profit by its ability to recognize different flowers quickly, but the flowers themselves benefit by possessing distinctive marks whereby the species may be easily distinguished. One reason for the diversity of colour, scent and form met with in flowers is doubtless to foster this habit of constancy. Flowers specialized for bees in particular exhibit great variety. The odours of flowers are also distinctive and highly characteristic, while marks on their petals usually serve as honey-guides; but the bright spots on London pride and other Saxifraga, and the tesselated draught-board pattern of the crown imperial, cannot be of much use in this way. Possibly their function is to aid the winged botanists in identifying the species.

The value of an insect's visit may be diminished, not merely by the transference of the pollen to flowers of another species, but also by its application to the stigmas of flowers growing on the same plant. Insects whose methodical instincts lead to the intercrossing of distinct plants are preferable to those which bring about the intercrossing of flowers growing on the same plant. A bee visiting a spike or raceme of flowers almost invariably enters the lowest flower first, and proceeds to the others in regular succession upwards. I directed the attention of Mr. Darwin to this subject, and he mentioned in a letter I had from him that he had observed bees visiting Tritoma in this way. Tritoma, better known as the red-hot poker, is a garden plant belonging to Liliaceæ; its inflorescence is an elongated spike, consisting of hundreds of tubular flowers. Tritoma is adapted to Lepidoptera. Bees must have difficulty in reaching the nectar, and I have not had an opportunity of observing them at work on its blossoms. On one occasion I saw a tomtit biting holes in these flowers to get their nectar; but although birds rarely do this, humble-bees regularly perforate the corollas of the heath and other blossoms. Quicker access is thus obtained to the honey, and the insect can remove it from flower tubes too deep for its proboscis. Hive-bees, when they can, make use of the holes made by the humble-bee in preference to entering by the mouth of the flower. The ascending habit appears, however, to be common alike to the hive-bee and the wild species. For a time I was at a loss to account for this order of visitation, but the action of the insects themselves suggested the explanation. I noticed that they rarely went up the whole length of a spike, and sometimes only entered one or two of its lowest flowers. It then occurred to me that as the lowest flowers were also the oldest and most advanced, they were more likely to contain nectar than the younger ones higher up the spike. An additional hint was afforded by Mr. Darwin's observation that, on visiting a flower with several nectaries, a bee, if it finds one of them empty, does not stay to examine the

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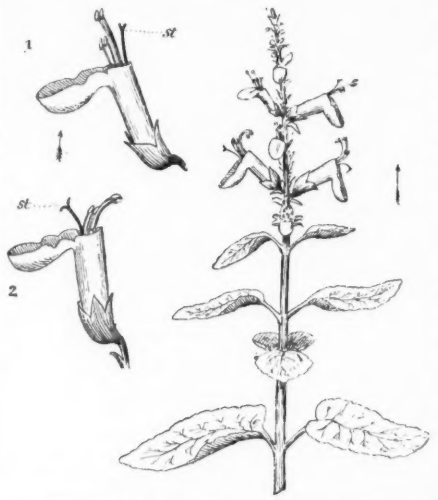
others, but immediately flies off to another blossom. The ascending habit is an extension of the same principle. Begining at the bottom flower and going regularly upwards, the bee applies to the inflorescence the same principle which it adopts in the case of a flower having several nectaries, for on coming to a flower with no nectar it learns at once that to visit the flowers above this would be labour in vain. The advantage of the ascending method is that it enables the bee to avoid a great many useless visits to newly-opened honeyless flowers towards the top of the inflorescence. A further advantage of this system is that the bee is informed in the first flower it enters if the spike has already been visited, and if so, it can at once turn its attention elsewhere. Such systematic visitation must, therefore, result in a considerable saving of time.

The first plant on which I remarked bees proceeding in this manner was the gladiolus. The flowers of this plant are dichogamous, as those blossoms are termed in which the essential organs mature at different times. As is the case with most conspicuous flowers, the dichogamy is protandrous, that is, the stamens of each flower ripen before its stigma. Self-fertilization is improbable, as all, or nearly all, the pollen is shed before the stigmas expand. In their first stage the flowers are functionally male; in the second they are female. Another difference between the two stages exemplified in Gladiolus is that the stamens and stigmas change their relative positions. At first the stamens are bent forwards; the anthers stand in the fairway to the nectar, and it is impossible for a bee to enter without encountering them and dusting itself with their pollen. Meanwhile the unexpanded stigmas remain in the upper part of the flower, behind the anthers and quite out of the way of visitors. When the flower passes into the second stage the stamens, having scattered their pollen, straighten up and occupy the upper portion of the flower, beyond the reach of visitors. The style now bends forward and the stigmas uncurl in the entrance to the flower, so that no bee can enter without touching them. By the time the older or lower flowers have attained the second or female stage, many of the younger ones higher up the spike can only have reached the stage in which the pollen is discharged. Hence, a bee entering the lowest flower pollinates its stigma with pollen brought from *another plant*, and proceeding upwards comes to younger blossoms, where it is dusted with pollen, which it carries off with it to the next spike, where the same thing is repeated. Were the bee to begin at the top and work downwards, it would waste its own time searching flowers not far enough advanced to yield nectar, and simply transfer the pollen of the upper blossoms to the stigmas of the older flowers farther down the same spike. This, indeed, would be a kind of cross-fertilization, but the experiments of Mr. Darwin have conclusively shown that the intercrossing of flowers belonging to the same individual plant yields results little, if at all, better than self-fertilization. So numerous are the provisions in flowers for preventing self-fertilization that there is only one possible conclusion, viz.: that the acropetal inflorescence and protandrous flowers constitute a special adaptation to the ascending habit of insects intended to secure the intercrossing of distinct plants.

The wood sage, one of our commonest labiates, illustrates even better than the gladiolus this provision for the intercrossing of different plants. Its flowers, as will be seen from our illustration, are, like those of Tritoma and Gladiolus, protandrous. The stamens having shed their pollen bend backwards over the upper edge, and the stigma which at first is behind the stamens bends forward and occupies the entrance of the flower. The number of flowers on each spike is usually much greater than shown in the sketch. They are developed acropetally, and as the bee in visiting them usually adheres to the ascending habit they must, in most cases, be fertilized with pollen from a different plant.

The common figwort is visited chiefly by wasps. On this plant I have repeatedly observed a wasp begin at the uppermost flower and work downwards. But this apparent exception only confirms the explanation just given, for the flowers of the figwort are protogynous, not protandrous, the stigmas being in advance of the stamens, and although the inflorescence develops somewhat differently the arrangement here also leads to the intercrossing of flowers belonging to different plants.

Simple flowers have the honey exposed and easily accessible to all insects, but in more highly developed blossoms it is often so completely concealed that only intelligent visitors can discover it. Sprengel long ago noticed the stupid manner in which flies behave when searching for nectar. One of the carrion flies constantly misses its aim when trying to insert its proboscis into the flowers of bistort. Beetles are equally awkward and make many ineffectual attempts to reach the honey of Erodium. Such stupidity is, however, characteristic only of short-lipped species, for it has been shown that structural adaptation and intelligence advance together.



The Wood Sage (*Teucrium scorodonia*).

1. Young upper flower in male stage. 2. Older lower flower in female stage. *st* Stigma.

Among flower-haunting insects a long proboscis is indicative of a high grade of intelligence. Butterflies are especially deft, thrusting their proboscis into flowers and withdrawing it with astonishing swiftness and precision. The dexterity of the more specialized bees is almost equally great, though even bees may be seen sometimes fumbling about in vain for the entrance to the nectary on flowers with which they are not familiar. They soon recognize the value of the guiding lines on petals, and, following them, overtake more work. In this way they are induced to enter flowers in the manner most calculated to effect cross-fertilization. Less intelligent guests, unable to interpret the honey-guides, might remove the nectar without conferring any benefit on the flowers. Changeable flowers like Ribes indicate to intelligent visitors if they have already been visited, and divert the less intelligent from the unvisited blossoms still containing nectar. Sharp-witted guests alone are likely to enjoy the honey in the deceptive flowers of Parnassia. The blaeberry, again, illustrates a class rich in nectar, but rather obscurely coloured and frequented by bees sufficiently wise not to be misled by appearances. Flowers are thus adapted not only

to the bodily size and shape of their guests, but are also specialized in relation to their habits and degrees of intelligence.

One or two considerations may be mentioned to show in what way the social habit must affect the value of insects as fertilizing agents. Since the concerted action of an organized community involves division of labour, those individuals on whom the duty of collecting honey falls will visit a larger number of flowers than they would if every duty were shared alike, and in consequence of this increased industry the value of the workers' visits will be enhanced. As a second effect, bees scatter to their task, members of the same hive tending to spread rather than to hunt in packs. On one occasion I noted three butterflies and one bee on the same thistle-head; but butterflies are not socialists like the bees, whose interest it is to keep out of each other's way as much as possible, and avoid competing keenly with one another. Hence the ascending habit is of special importance to social insects.

Two summers ago I had a good opportunity of observing how bees go about their work on a rich bed of white clover. On chilly days, when few insects were at work, they did not visit systematically, but only entered a few flowers on each head of clover. It seemed as though, revelling in abundance, they had relaxed their methods, and were acting on the generous principle of not reaping the corners of their fields; but perhaps the scanty secretion of the nectar, in consequence of the cold, might have something to do with it. Be this as it may, on sunny days, when many insects were at work, the bees behaved quite differently, seldom leaving a clover-head until they had exhausted every one of its numerous florets. The intense activity and the careful, systematic procedure of the little toilers suggested the idea that possibly the hum of neighbouring workers exercised some influence upon their actions. Everyone knows the kind of inspiration for work which one experiences when the sights and sounds of industry are all around. Music is known to possess a remarkable charm for spiders, and there is not a little fascination about the notion that bees somehow stimulate and encourage each other by humming. In studying the organization of flowers, too, one is deeply impressed by the thoroughness with which Nature does her work; nothing is left to chance, no stone is unturned, no precaution omitted that can conduce to the end in view. Flowers, we might almost say, have honey for the diligent, the intelligent, the systematic worker; none for the careless, the capricious, or the idle. Nor is it otherwise in human experience, for nothing can be less remunerative than desultory work.

Science Notes.

South Australian papers to hand bring details of the tremendous upheaval on the island of Ambrym, one of the New Hebrides, in the Pacific Ocean, nearly one thousand four hundred miles north-east of Sydney. The region is naturally volcanic, and more or less in a chronic state of disturbance, but the last upheaval seems to have been the greatest in historic times. The island was partially explored a few weeks after the subsidence of the upheaval by Captain Cust, of Her Majesty's ship "Dart," and he reports that the centre is a perfect "sea of lava, with the hills sticking up through its surface like islets." The surrounding country is covered with ashes, and all vegetation is temporarily destroyed. The crater is roughly estimated to be three miles in circumference, and "the wall is from eight hundred to one thousand seven hundred feet above the level of the floor." The last census taken of the population of this island, mostly savages, speaking various and very primitive dialects, put the figures at "about eight thousand," but Captain Cust reports that "few seem now to be found"—probably most of them having perished.

At the last meeting of the Anthropological Institute a most interesting paper on the Samoyads was read by Mr. Arthur Montefiore. Up to the present very little has been known about the history or even ordinary life customs of this people, and about ten years ago it was feared that a terrible outbreak of small-pox would have cleared them off the face of the inhospitable bit of the globe they inhabit, namely, the Arctic coast of the Russian Empire, west of the great river Yenisei. Their religion has been described as a mixture of northern paganism and fetichism, and their morals peculiar—even to the point of being scrupulously honest in all their trading transactions. In his paper, Mr. Montefiore, after dealing with the geographical distribution of the various branches of the Samoyads, proceeded to treat of their affinity with the Finns, placing them in the Ural-Altaic group, thus following the theories of Castrèn. This inference appears to have been largely based on a study of their language, customs, folk-lore, "religious" beliefs, or myths, and physical characteristics.

A remarkable village of cliff-dwellers, perhaps the most wonderful of the kind ever discovered, has just been found in an almost inaccessible cañon in the Bradshaw mountains, in Arizona. The cañon was discovered by accident by two prospectors, who did not attempt a thorough exploration, owing to the great size of the ancient settlement. From the description given by them there is no doubt that this is the largest village of the kind ever discovered. It is located along the high banks of Willow Cañon, and the houses are estimated to number two hundred and sixty. It is a difficult matter to reach the cañon even with pack animals, which accounts for its having been so long undiscovered. There are three natural terraces in the cañon wall, the dwellings opening back from them, and a flight of narrow steps in the rock—now almost worn away—seems to indicate that this was the method employed in ascent and descent. Several of the houses were explored, and large quantities of pottery and some instruments, evidently used for cultivating the soil, were found. In one house a skeleton of a man was discovered, not over four feet eight inches in height. A party is being organized to explore the newly-found village, and it is hoped that interesting discoveries will be made to throw further light on the history of these remarkable people.

Notices of Books.

A Handbook to the Primates. By Henry C. Forbes, LL.D., F.Z.S., &c. Vol. I., pp. 283. Vol. II., pp. 257. (London: W. H. Allen & Co., Limited, 1894.) "The Naturalist's Library," to which this pair of volumes belongs, promises to contain by far the best collection of works on natural history. Sixty years ago the volume on monkeys was published in Jardine's archaic "Naturalist's Library," but it would be kinder, perhaps, not to dwell upon the caricatures which illustrated that work. We cannot help thinking of them, however, as we look at and admire the fine plates in the volumes under review. In the first volume, Dr. Forbes gives an account of the lemur-like animals (Lemuroidea), and the man-like animals (Anthropedia) so far as the baboons and mangabeys, while the second is devoted to the remainder of the monkeys, and the apes, and to a set of tables and maps showing the

geographical distribution of the order *Primates*. To say that the work forms a complete monograph of the order would be to claim for it what everyone familiar with the great advances in zoology during the past half century would know to be untrue. But at the same time we have no hesitation in saying that in these instructive handbooks Dr. Forbes has given the public the benefit of his knowledge, with the result that, for conciseness and accuracy, they together make an ideal text-book for the student and a desirable work of reference for the well-informed reader. Much remains to be done before our knowledge of the Primates and their distribution will approach completion, but that which has been accomplished is carefully and cleverly epitomized.

Cloudland: A Study of the Structure and Characters of Clouds. By Rev. W. Clement Ley, M.A., F.R. Met. Soc., Pp. 208. (London: Edward Stanford, 1894.) Mr. Clement Ley, than whom there is no higher English authority on the forms of clouds, deserves the gratitude of meteorologists for this most important addition to their literature. The preparation of the book has involved an immense amount of labour—so great, indeed, has been the toil, that it has seriously impaired the author's health. There are several reasons why the task should have been so difficult. Not only are clouds vague and intangible objects, but the causes which produce them are very complicated, and meteorologists generally have eschewed the subject, forgetting that the co-ordination and study of clouds would probably lead to the discovery of important connections between them and the weather. The author's main object has been to help and interest individual observers in this neglected branch of meteorology, and thus to aid the growth of the science; and, in our opinion, he has produced a work so attractive in illustration, and untechnical in text, that it cannot fail to extend the observation of "the nurslings of the sky." The volume is enriched by a number of reproductions of Mr. Arthur Clayden's beautiful photographs, and a few coloured plates representing water-colour sketches made by the author. It will certainly be the *vade mecum* of all students of nephology.

A Handbook of the British Macro-Lepidoptera. By Bertram Geo. Rye. Illustrated by Maud Horman-Fisher. Vol. I., Part 1. (Ward and Foxlow; 2s. 6d.) At length we have before us coloured illustrations which are true to Nature, and do not partake of the gaudy and highly-coloured plates so often seen in works of this kind. The first part of Mr. Rye's handbook, just published, does not, it is true, deal with the insects most difficult to represent in colours, but it contains enough of Miss Horman-Fisher's excellent work to assure us that the high standard will be maintained. The text, which chiefly deals with the metamorphoses and classification of the Lepidoptera, is concisely and simply written.

A Treatise on Chemistry. By Sir H. Roscoe, F.R.S., and C. Schorlemmer, F.R.S. Vol. I., The Non-Metallic Elements. (Macmillan & Co., 21s.) The new edition of the first volume of this valuable work contains considerable additions. The fresh matter in the introductory part of the volume includes an account of the recent researches on osmotic pressure, which have thrown so much light on the nature of solution, and have led to an important new method for determining the molecular weight of a dissolved substance from the lowering of the freezing-point of the liquid in which it is dissolved. When a dilute solution of sugar or other crystallized substance is placed in a vessel whose walls are formed of a "semi-permeable" material—*i.e.*, one which allows water to pass through it but prevents the outward passage of the dissolved substance, the pressure inside the vessel is observed to rise. This pressure is called the *osmotic pressure*, and is found to play the same part in the theory of dilute solutions as gaseous pressure in that of gases. The osmotic pressure depends on the nature of the dissolved substance, the concentration of the solution, and the temperature. The values given for the atomic weights of the elements have been revised, most of them being now represented by a smaller number, the value for that of oxygen, from which many of the others are derived, having been reduced in accordance with the latest researches to 15·88 in place of 15·96, which was the number given in the last edition of this work.

A noticeable feature of this treatise is the representation in the illustrations of the principal apparatus used in chemical research, and in the technical applications of chemistry. These are given with great clearness. In the description of Pictet's process for liquefying gases, the scientist's account, included in the former edition, of how he obtained a steel-blue liquid jet of hydrogen and heard a rattling hail of solid hydrogen particles, is omitted in this, the author perhaps agreeing with the opinion expressed in a French text-book that M. Pictet must have been the victim of an illusion.

A further account is given of Moissan's recent interesting work on the preparation of fluorine, which for so long resisted all the efforts of chemists to isolate it.

Care seems to have been taken to embody in this volume a description of discoveries which have taken place since the publication of the previous edition. For example, the composition and properties of phosphorous oxide, as shown in the experiments carried out a short time ago by Thorpe and Sutton, are described. In place of the sentence "All attempts to obtain the diamond artificially have as yet been unsuccessful," which appeared in the edition published six years ago, there is now a description of the interesting method of Moissan, by which he has obtained artificial diamonds by allowing carbon to crystallize from solution in iron under a high pressure. Amongst other additions which might be mentioned is that of a few paragraphs on the bacteriology of the air. References are given throughout to some of the principal original memoirs, which will be valuable to the student who wishes further information on any point.

The clearness of the printing is much conducive to comfort in reading, and some misprints which occurred in earlier editions have been corrected. With the new matter embodied in the text this first part of the treatise forms a full and reliable guide to the present state of knowledge of the descriptive chemistry of the non-metallic elements.

The Aëronautical Annual, 1895. Edited by James Means. (Clarke & Co., Boston, Mass.) One dollar, post free. This first annual, on the now recognized important subject of navigating the air, is well worthy of perusal. Mr. Means has wisely begun at the beginning of the records. Starting with Leonardo da Vinci, who was born in 1452 and died in 1519, the reader is favoured with a fine portrait of that remarkable man, reproduced from a drawing in red chalk, by himself, in the Royal Library, Turin. Da Vinci was certainly a man far in advance of his time. After selecting some of his most important achievements, the editor passes on to the writings of Sir George Cayley, 1809; Walker, 1810; and Wenham, 1866. Then follow some old curiosities, which are very amusing, though not of much scientific value. Then, in succession, Darwin, Henson, and others are mentioned. Notes on the bibliography of aëronautics, and references to Mr. Chanute's literary labours, with valuable suggestions by the editor, make it altogether a very readable book to all interested in the navigation of the air.

BOOKS RECEIVED.

Allen's Naturalist's Library. Edited by R. Bowdler Sharpe, LL.D. A Handbook of the British Mammalia. By R. Lydekker, B.A., F.R.S. (W. H. Allen & Co.) 6s.

Lens Work for Amateurs. By Henry Orford. (Whittaker & Co.) 3s. A practical handbook, containing excellent instructions to young workmen and amateurs for the manufacture of lenses.

The Age of the Condottieri. By Oscar Browning. (Methuen & Co.) 5s. A short history of Mediæval Italy, from 1409—1530, furnished with an excellent index.

One Thousand Patent Facts. By Robert E. Phillips. (Iliffe & Son.) 2s. 6d. A compact and comprehensive work dealing with the laws and rules governing the protection of Inventions by Letters Patent, and the registration of Designs and Trade Marks.

The Great Problem, or Man's Future Place in the Universe. By J. S. (Elliot Stock.)

Annual Report of the Smithsonian Institution, for the Year ending June 30th, 1892. (Government Printing Office, Washington.) An elaborate report, containing a great number of beautiful plates from photographs of specimens in the United States National Museum.

Proceedings of the Academy of Natural Sciences of Philadelphia. May—September, 1894.

Calendar of the Department of Science and Art, 1895. (Eyre & Spottiswoode.) 2s. 5d.

Progress of Science. By J. Villin Marmery, with an Introduction by Samuel Laing. (Chapman & Hall.) 7s. 6d.

Mechanics—Theoretical and Practical—Dynamics. By R. T. Glazebrook, M.A., F.R.S. (Cambridge University Press.) 4s.

The Story of the Stars. By George F. Chambers, F.R.A.S. (Geo. Newnes.) 1s.

Substance and its Attributes derived from the Absolute. (Kegan Paul & Co.)

Remarkable Comets. By W. T. Lynn. Third Edition. (Edward Stanford.) 6d.

A Handbook of Illustration. By A. Horseley Hinton. (Dawbarn & Ward.) 3s. net.

Chemical Laboratory Labels. Compiled by W. H. Symons, F.I.C. (Gallen, Ramp & Co.)

The Royal Natural History. Edited by Richard Lydekker, F.R.S. (Frederick Warne & Co.) 1s. Vol. III., Part 16, commences the portion of this work to be devoted to birds. The introductory matter referring to the general characteristics of the class Aves is well and soundly dealt with. The illustrations, however, fall short of our expectations.

THE CAUSE OF THE MOVEMENT OF GLACIERS.

By P. L. ADDISON, F.G.S., Assoc. M. Inst. C.E.

TO some readers there may not at first appear anything very interesting in the movement of glaciers. Such is, however, the case with many of the phenomena in Nature, and it is not till we seek to unravel the intricate relationship in the family of physical forces, which produce great changes on the face of the earth, that the interest becomes absorbed in that which we thought worth little attention.

There is something so profoundly mysterious in the regular method employed by Nature in carrying out her designs, that if we simply recognize her work, without even in a superficial manner investigating the method by which it is produced, the "pith and moment" is all but lost; we, in fact, but look on the outside cover of a book of fairy tales without enjoying the charming stories it contains, and thus leave the "Rhymes of the Universe" unread.

We are familiar with the appearance of glaciers as they lie in valleys and mountain clefts, and have observed how, if two valleys converge and join one another, the ice-sheets they contain combine in one mass, as two rivers would do, although the ice forming the glaciers is often several hundred feet in thickness, and seems to be an inert mass of solid matter. There is no doubt, however, that a glacier moves down the valley very much in the same way as a river, but, of course, more slowly. The motion is quicker on the surface, and slower at the bottom and at the sides. But we must not carry this comparison any further; the physical conditions of the two streams are not the same, and their motion, though in many respects similar, is widely different in degree and origin.

It is hardly necessary to point out that a glacier does not *slide* down the valley which contains it. The well-proved differential movement, the inequalities of the ground over which it passes, and the bends round which it has to turn, render sliding motion impossible. And besides this, the apparently rigid glacier creeps down slopes on which soft clay or loose shingle remain practically immovable.

If we examine a piece of ice, say for example an icicle, we find that it is exceedingly brittle; if thrown down upon the ground, it breaks into many pieces. A piece of soft clay can be bent or compressed into any shape with ease, and yet an ice-sheet, of exactly the same composition as the icicle, will steadily flow down slopes so gentle that soft clay will stand on them without moving at all. When a bed of clay moves down a hill-side the particles of which it is composed slide past and roll over each other till they come to a state of rest at the bottom, but as the ice could not behave in this manner, other causes must be sought to account for glacier motion.

There is a peculiar irregularity in the movement of glaciers, which probably first led to the discovery of the cause, and this is that the motion is quicker during the day than at night, and the summer rate is often double that attained during the winter. This shows that pressure from behind cannot be the cause of the motion, for, through the greater accumulation of ice and snow on the higher levels, the pressure must be greater during the winter season when the movement is least. The fact that the motion of the ice-sheet is greater during the day than in the night, and in summer than during winter, naturally leads us to conclude that *heat* must indirectly have something to do with the phenomenon, for the movement is greatest during that part of the twenty-four hours when the ice is subjected to the sun's rays, and in the warmer seasons of the year. An examination of the physical properties of the glacier will show how it can be affected by heat and yet, as a mass, remain in the form of ice.

When a thin slab of ice is subjected to microscopical examination, it will be seen that it is not, as it appears to the naked eye, a homogeneous mass of solidified water, but a confused agglomeration of minute crystals, with cavities equally minute lying between them. A glacier is simply water in a crystalline state, and any motion in the mass involves the movement of the crystals of which it is composed.

It has already been mentioned that the flow of the ice-sheet is quickest at the centre and on the surface, and slowest at the bottom and against the sides of the valley; it follows, therefore, as the motion is differential, that the ice crystals in the centre of the glacier must pass by those composing the sides and bottom. This appears to raise a difficulty, for if the minute crystals were to *crush* past one another, owing to their travelling at different speeds, they would soon be ground to a fine powder. This does not, however, take place, and the ice-sheet remains a solid and brittle mass.

We know that water freezes at a temperature of 32° Fahr., and in doing so it gives out a certain amount of heat and assumes a crystalline form, and at the same time expands about ten per cent. in volume. In other words, one cubic foot of ice at 32° Fahr. will only make ·908 of a cubic foot of water at the same temperature, and a cubic foot of water at 32° Fahr. will expand to 1·102 cubic feet of ice. If, therefore, water is compelled to assume a solid condition, a mechanical force is at once exerted through the necessary expansion of the substance in freezing. An experiment was tried to keep water while it froze enclosed in an iron bombshell thirteen inches in diameter.

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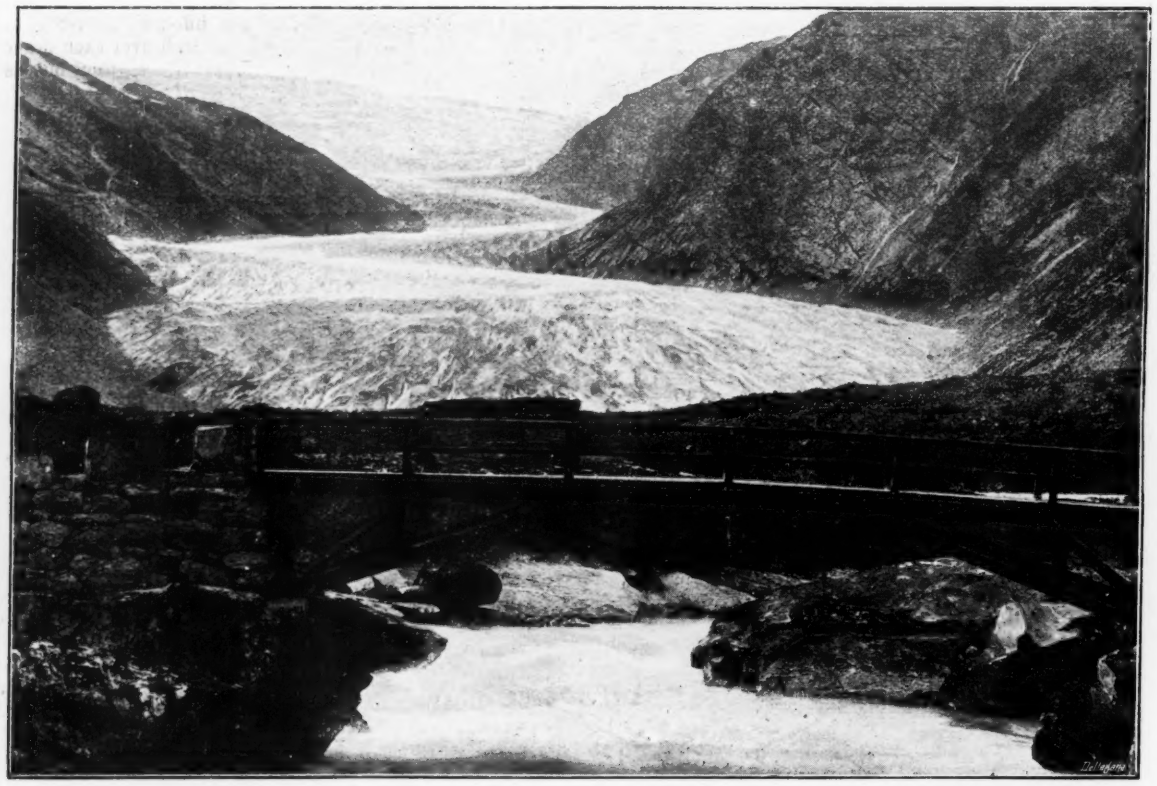
The shell was filled with water and the hole securely stopped up with an iron plug weighing three pounds. When the freezing process began the water expanded, and something had to give way in order to provide accommodation for its increased bulk. So great was the force exerted that the plug burst from the shell with a loud report and was projected to a distance of nearly one hundred and forty yards, and the ice protruded from the plug-hole in the shape of an icicle eight inches in length. Another shell was filled in a similar way, and the plug was more securely fastened, but when the water froze the shell burst, and the ice spread out all over the cracks. The mechanical force exerted in both these experiments was unmistakable.

But let us note the peculiar behaviour of the ice. In the one case it spurts out from the plug-hole and remains there, joined with the ice inside the shell, a brittle icicle eight inches long. If the ice had been of the consistency of putty, this form of protrusion is what one would have expected, but when it occurs in a brittle and crystalline substance, it demands thought and consideration.

On account of the very low temperature to which the shells were subjected, the greater part of the contents would be formed into ice. This is indeed a necessary condition in order that sufficient pressure might be exerted to prevent all the water from freezing. Inside the shells there would be a crystalline mass, the minute interstices of which would be filled with molecules of liquid water ready to freeze the moment the pressure acting on them was reduced. This moment arrived when the shells gave way. The molecules of water began to assume a crystalline form, some in the interspaces, and some outside. The compressed water spread over the cracks, and through the plug-hole in the shells, and there instantly turned into ice, while other molecules of water inside, becoming solid, pushed with irresistible force in all directions the crystals already formed. Thus there was an expenditure of energy, and an amount of work done by the water in giving up heat it had derived from the sun, and in assuming a crystalline condition.

In order to make this point more clear, we may briefly mention another well-known experiment with water and ice.

Take a pound of water, the temperature of which is 80° on the Centigrade thermometer scale, and mix it with a pound of water at 0°, or freezing point; the mixture will make two pounds of water, the temperature of which is 40° Centigrade.



Jostedal Glacier, Norway. Illustrating the zigzag course of a Glacier, with the source of supply in the distance, and the terminal river in the foreground.

From a photograph by] [*Valentine and Sons.*

Now take another pound of water at 80° Centigrade, and mix with it a pound of crushed ice—that is, ice crystals—at 0° Centigrade, the same temperature as the cold water in the first mixture, and the result is that we have two pounds of water at freezing point.

In both cases the weight of matter at 0° Centigrade introduced into the warm water was the same; how then is it that in the latter experiment the water is reduced 40° lower than in the former? Before the ice-crystals could assume a liquid condition they had to absorb a certain amount of heat. That heat was drawn from the warm water, and consequently reduced its temperature, but it did not raise the temperature of the ice; it simply acted as energy in enabling the ice to become liquid, and remained in that liquid in the form of latent heat, to be

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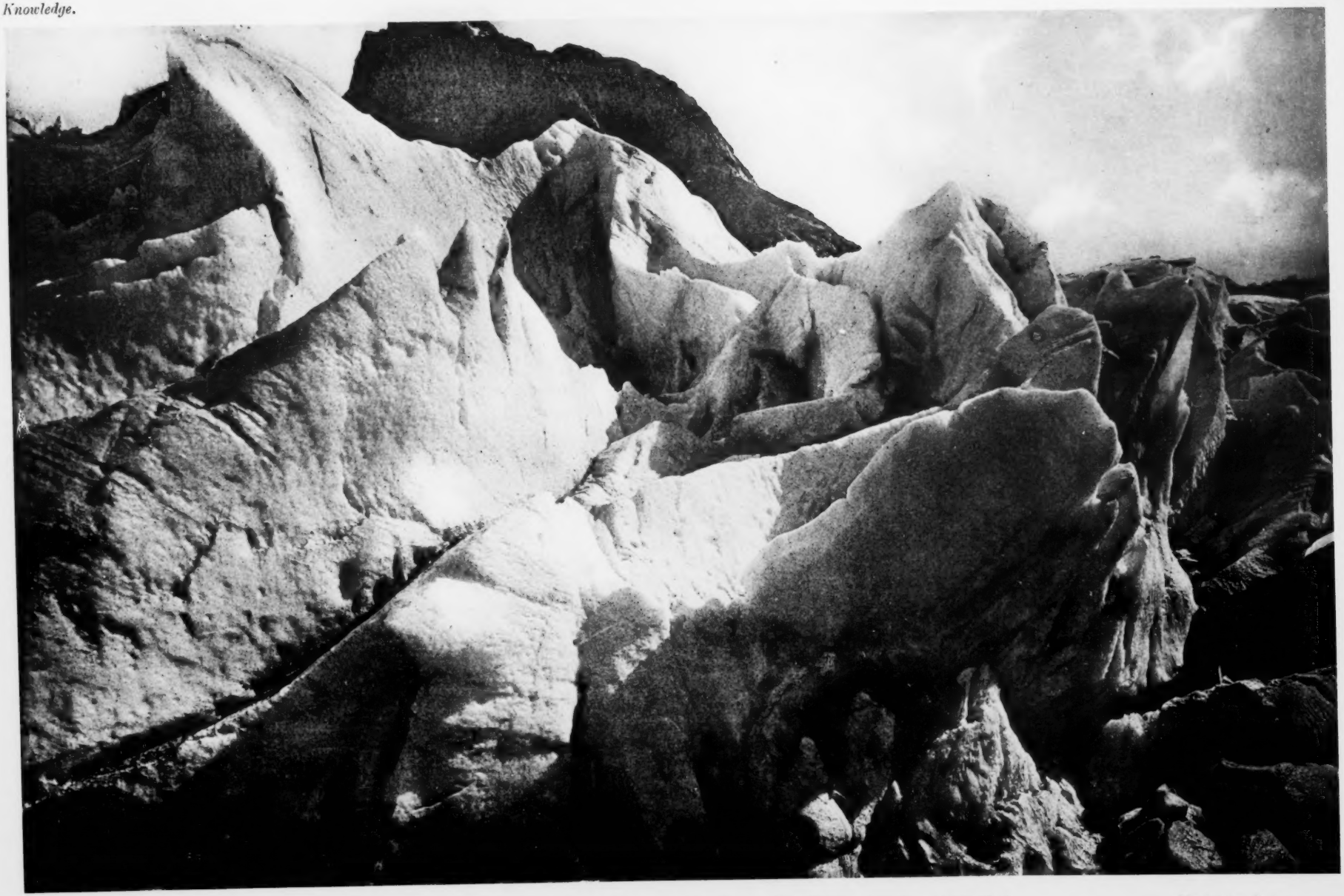

From a photograph by] **A PORTION OF THE BONDHOUSE GLACIER, MARANGER FJORD, NORWAY.** *[Valentine & Sons.*

Illustrating the apparent rigidity of a large mass of ice.

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given up again as soon as the water reassumed a crystalline form. One other question may very naturally occur to the reader, namely, if heat is required to melt ice, how is it that water and ice can exist separately at the same temperature? In the first place, water at freezing point is in an incipient state of crystallization; and secondly, from the commencement to the end of solidification the temperature of a liquid remains constant.

Let us now attempt to apply the foregoing principles of the expansion of ice on a small scale to the movement of glaciers, and other great ice-sheets.

The sun, in expending its rays on the surface of the glacier, does not raise the temperature of the ice of which it is composed; it, however, imparts energy, which, with gravitation, causes the glacier to move along that path where, as a whole, it finds least resistance to its motion.

The method may be thus described:—The heat of the sun melts the ice on the surface of the glacier, and it contracts in bulk on becoming liquid, and flows downwards by the aid of gravitation into the interstices between the ice-crystals below. Here the water is no longer influenced by the sun's rays, and again becomes crystalline, but the crannies and corners into which it has found its way are not suitable in shape to contain it in the form of crystals, and therefore in parting with its heat it employs that irresistible force due to crystallization to make the cavities larger. In other words, it pushes away the molecules surrounding it down the path of least resistance. But we must not forget that the molecules of water on becoming re-crystallized part with latent heat. This heat is taken up by adjacent molecules of ice, which, in their turn, become water, flow downwards and exert pressure in the process of re-crystallization. Thus, little by little, and from molecule to molecule, the heat derived from the sun is transmitted through the length and breadth of the glacier. The action is not at one place alone, but permeates the whole mass. We must look upon the glacier as an agglomeration of moving molecules, which, having utilized gravitation to enable them to flow downwards when in a liquid state, follow up that movement by an overpowering pressure produced during their process of re-crystallization.

But how is it, if a glacier is constantly receiving heat on its surface which passes through its entire thickness, that it does not in time all melt? Like other rivers, glaciers are constantly being fed with fresh material from their sources and by tributaries, and this supply neutralizes the waste which actually does take place, and which is represented by the terminal streams of water—the origin of some of the greatest rivers in the world. A glacier receives heat and energy from other sources than the direct rays of the sun on its surface. Radiation from the earth, and tepid water entering the larger fissures of the ice, convey heat into the interior which, in its action, produces exactly similar effects to those caused by the direct rays of the sun.

If this molecular theory of the movement of ice is the true one, there is no difficulty in accounting for the peculiar manner in which glaciers adapt their shape to the inequalities of the ground over which they flow. It is true that crevasses may be formed, owing to a sudden alteration of slope producing a transverse strain across an ice stream, and thus breaking it in two or forming deep cracks (to be healed, eventually, by the process of regelation) before the molecular movement can adapt the glacier to the form it is required to take; but if time is allowed, ice has shown itself to possess wonderful qualities in adapting itself to the nature of the valleys in which it moves.

Perhaps the most striking examples of this kind are furnished, not by existing glaciers, but by those of the last glacial period, when on Northern Europe the land ice extended much farther south than it does at present, and was of enormous weight and thickness. During that period, rock basins, which now form large lakes, were filled with ice, and in some instances it has been shown that they were carved out of hard rock by glacial action.

The directions in which the ice moved during this cold period in Northern Europe is ascertained from the marks it caused to be made on the hard rocks over which it passed. The striæ are a certain indication of the trend of the ice-flow, and prove that the ice not only travelled down the slope into the rock basin, but that it also *rose up* the slope at the other end, although the surface of the glacier might be several hundred feet above.

This fact demonstrates more conclusively than any other example that could be given, the complex molecular movement in every part of a glacier. If the ice had moved by pressure from behind, and by gravitation, as it would affect a mass of plastic clay, it would have first filled the lake basin, and then continued to flow over the top. But this was not the case. It moved on the top, it moved in the middle, and it moved at the bottom; each molecule in the entire mass was constantly taking in energy from heat and acting alone, and giving out energy and acting in conjunction with its neighbours in converting that energy into motion.

With regard to the striated surface of some of the harder rocks over which a glacier has in bygone ages flowed, it might at first be thought that these markings pointed more to a sliding than to molecular motion. It must, however, be remembered that the striæ are produced, not by the ice itself, but by graving tools in the form of stones, which it carries with it in its general motion. These stones, loosened from the ground, become imbedded in the ice, cutting and grooving the solid rock surfaces beneath, they themselves being ground down in the process.

There is another circumstance which tends to prove that glaciers in their interior are not inert masses of ice. This is the habit they have of disgorging stones and other foreign matter on their surface. An example of this tendency is that a knapsack, having been dropped into a crevasse, found its way to the surface of a confluent glacier ten years later, and more than three-quarters of a mile from the place where it had been lost.

There is, it appears, no means of arresting the movement of glaciers except by cutting off entirely their supply of heat, and this for a sufficient time to allow them to get rid of that which they have already absorbed.

Perhaps the most interesting direction in which these considerations lead us is towards the study of the action of glaciers and ice-sheets during the last and former glacial periods. Evidence of this action is to be found on every hand, and it is often strange to think as we stand in the warm sunshine in a pleasant wooded valley, decked with every variety of vegetation, that about the time when man apparently first appeared on the earth the place lay hundreds of feet below a great sea of ice which overspread Northern Europe.

Enough has been said to draw the attention of the reader to the means employed by Nature for carrying out the work which she desires to perform. She employs no labour nor constructs elaborate machines to do her will, but, through the reciprocal relationship of the physical forces, causes great changes to take place in the universe, which, simple as they may seem to be in the abstract, like the movement of glaciers, are, though complex in the extreme, superbly accurate and efficient in every detail.

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NEW ANIMALS FROM MADAGASCAR.

By R. Lydekker, B.A.Cantab., F.R.S.

At a time when public attention is directed to Madagascar as the scene of an impending war, our readers will doubtless be glad to hear something of certain new discoveries which have recently thrown much additional light on the past zoological history of this most interesting and remarkable island. Probably many of them are aware that the Malagasy fauna differs most strikingly from that of the African mainland, in spite of the small extent of sea by which the two areas are separated from one another; and it is evident that although the ancestors of the majority of the animals now inhabiting Madagascar obtained an entrance by means of a former land connection with East Africa, yet the date of that connection must have been extremely remote. At the present day, Africa south of the Sahara desert is specially characterized by the numbers of species of antelopes of various genera which swarm on its open plains, as well as by giraffes, zebras, rhinoceroses, elephants, hippopotami, wart-hogs, bush-pigs, lions, leopards and various other large cats, baboons, man-like apes, and ostriches. On the other hand, with the exception of one living species of bush-pig and a fossil hippopotamus, not a single representative of any one of these groups is met with in the adjacent island; and, as has been pointed out by Mr. Wallace, it would appear quite probable that both the pig and the hippopotamus may have obtained an entrance by being carried across the channel—possibly at a time when it was somewhat less broad than at present. In place of the animals mentioned above, we find in Madagascar numbers of lemurs, all belonging to genera and species distinct from those inhabiting either Africa or India, and so numerous that they form nearly one-half of the whole mammalian population of the island. Civet and ichneumon-like carnivores, likewise pertaining to peculiar genera, are also abundant, and these seem to affiliate the fauna to Africa rather than to Asia, seeing that such animals are more numerously represented in the former than in the latter continent. Among the most remarkable of these civet-like creatures is the so-called fossa (*Cryptoprocta*), which has a uniformly sandy coat, and may be compared in point of size to a short-legged lynx; this creature differing so markedly from all its allies as to be entitled to represent a distinct sub-family by itself. It has, indeed, been considered that the fossa is closely allied to certain extinct carnivores from the lower Tertiary deposits of Southern Europe, and although some writers are disinclined to accept the relationship, it is not improbable that the theory is well founded. One of the most remarkable features connected with the mammalian fauna of the island is the circumstance that the family of the insectivorous order known as the *Centetidæ* is represented elsewhere only in the West Indies, although the generic forms inhabiting the two areas are distinct. Another apparent indication of American affinities is afforded by the presence of iguana lizards (*Iguanidæ*), which are now unknown in any other part of the Old World except the Fiji and Friendly Islands. Iguanas are, however, found in a fossil state in the lower Tertiaries of Europe, and it therefore seems probable that their present anomalous geographical distribution may be explained by dispersal from a common northern centre, although it has been thought to indicate a connection between Madagascar and South America. If this be so, a similar explanation will hold good in the case of the *Centetidæ*, although, in spite of statements to the contrary, these have not yet been discovered in a fossil state. It will likewise serve with regard to the occurrence of an identical genus of freshwater tortoises in Madagascar and South America, and also of certain resemblances between Malagasy and Australian reptiles.

With regard to the former connection between Madagascar and the mainland, the occurrence of marine strata of Eocene age in Egypt and other parts of Northern Africa proves that, at the period of their deposition, the portion of the latter continent lying to the south of the Sahara was cut off from Europe and Asia by an arm of the sea, so as to form an island-continent, in the same way as was South America during some part of the Tertiary epoch. Probably, soon after this, or in the upper Eocene period, this Ethiopian island, as it may be called, of which Madagascar evidently formed a part, was temporarily connected with the northern land, when it received its fauna of civets, lemurs, and insectivores, which a subsequent disconnection allowed to develop without persecution from higher forms of later age. During this time Madagascar became separated, and in the upper Miocene or lower Pliocene age Southern Africa once more became connected with Europe and Asia, which (like North America) were then the home of the various large mammals mentioned above, as well as ostriches. This connection thus allowed a later and more highly organized fauna to sweep over Asia, where it found a free field to develop at the expense of creatures of a lower type. On the other hand, the isolation of Madagascar allowed the more primitive fauna to remain there unmolested, and to attain a richness of development which was never reached elsewhere. As to the date when the ancestors of the gigantic flightless Malagasy birds known as *Epyornis* obtained entrance into the island, further evidence seems necessary, as we are not at present aware that any nearly allied forms existed in the European Eocene, unless, indeed, we are to look upon *Gastornis* of the London Clay and corresponding strata of the Continent in that light. The giant tortoises, whose remains are found in the superficial deposits of Madagascar, belong to a group which was widely spread over Europe in Tertiary times, and their ancestors may consequently have entered with the primitive insectivores, civets, and lemurs. From Madagascar, according to the views of Mr. Wallace, the adjacent islands, which, in comparison, are exceedingly poor in mammals, received such forms of life as were capable of crossing the intervening sea; while, in their turn, they formed the stepping-stones by means of which the larger island was populated by such Indian birds and insects as had been able to reach them.

At the present day, the existing lemurs of Madagascar may be compared in point of size to small or medium-sized monkeys, the largest of them—the short-tailed indri—not measuring much more than a yard in length. The investigations recently carried on by various intrepid explorers in the island have, however, revealed the fact that up to a very late period Madagascar was the home of a lemur vastly exceeding in size any of the existing representatives of the group, and which in this respect may be compared to the great West African baboon known as the mandril. This giant lemur (*Megaladapis*, as it is called by its describer, Dr. Forsyth Major) is known by the somewhat imperfect skull and lower jaw, which are about three times the dimensions of those of the indri. The interest of this animal is, however, by no means confined to its comparatively gigantic proportions, since while its skull and teeth conform in their general structural features to those of the existing members of the group, they are specially modified in a manner altogether peculiar. The most striking peculiarity connected with the skull is the extreme slenderness of the hinder portion containing the brain in comparison with the great elongation of the face; the

latter seeming out of all proportion to the former. In this respect, indeed, the skull presents a curious resemblance to the so-called dog-faced baboons of Africa; as it also does in the strongly-marked ridges it bears for the attachment of powerful muscles. Such resemblances, however, it is almost needless to observe, are merely superficial, and must by no means be taken as indicative of any genetic relationship between the two groups; and if a young skull were forthcoming, it is probable that we should find this much less unlike ordinary lemurs. Another peculiarity of the giant lemur is to be found in the more lateral position and wider separation of the sockets of the eyes, which are also relatively smaller than in existing forms, thus indicating that the habits of the animal were less completely nocturnal than those of the latter. The molar teeth of the upper jaw are characterized by the presence of only three tubercles on the crown, owing to the fusion of the two inner ones of the four-columned molars of ordinary lemurs; a few of the smaller existing species having, however, teeth of a nearly similar type. Although in the type skull the front teeth are wanting, the form of their sockets shows that they must have been very similar in general form to those of living lemurs. In many respects the skull shows a marked resemblance to that of the European Tertiary lemur known as *Adapis*, a feature of especial interest in regard to what we have said as to the origin of the Malagasy fauna from that of the Eocene period in Europe.

The remains of the giant lemur were discovered in the great marsh of Ambolisatra, and their slightly mineralized condition indicates their comparatively recent age. Indeed, there is but little doubt that the creature has been killed off within the human period, and in his history of Madagascar, published in 1658, De Flacourt writes in the following terms of an animal then inhabiting the island, which, if not actually the giant lemur, would appear to to have been a closely allied form. He writes that "*Trétrétrétré* ou *Tratratratra*, c'est un animal gros comme un veau de deux ans qui a la tête ronde et une face d'homme; les pieds de devant comme un singe et les pieds de derrière aussi. Il a le poil frisoté, la queue courte et les oreilles comme celles d'un homme. Il resemble au *Tanache* d'escrit (*sic*) par Ambroise Paré. Il s'en est vu un proche l'étang de Lipomani, aux environs duquel est son repaire. C'est un animal fort solitaire, les gens du pays en ont grand peur et s'enfuient de lui comme lui aussi d'eux." With the exception of the rounded head and the size (which is doubtless exaggerated), this description accords remarkably with the giant lemur, and when the head was covered with fur it is probable that it would appear much less elongated than does the bare skull.

The giant lemur is, however, not the sole extinct member of the group recently brought to light, since the hinder part of a skull indicates another large species belonging to a new genus, but apparently allied to the existing Malagasy lemurs known as *Hapalemur*.

Although the extinct Malagasy hippopotamus (*H. lemerlei*) was named as far back as 1868, it is only recently that we have become fully acquainted with its affinities. In spite of its smaller size, it appears to have been nearly allied to the living African species. As it is somewhat difficult to believe that a hippopotamus and a bush-pig could have swum a channel of the width of that separating Madagascar from the mainland, it is not improbable that in the latter part of the Tertiary period this was much narrower—perhaps not more than ten miles in width.

From the same marsh of Ambolisatra which yielded the remains of the giant lemur have been obtained the eggs and bones of the gigantic Malagasy birds known as *Epyornis*. From the enormous dimensions of the eggs (one of which was recently sold in London for upwards of sixty-seven pounds) it was evident that some of these birds must have been of gigantic proportions, but till lately bones had not been obtained of commensurate size. Certain limb-bones recently received by Mr. Walter Rothschild enable us, however, to realize the gigantic stature attained by the largest species of these birds—a leg-bone, or tibia, measuring no less than thirty-two inches in total length.

Probably some of the species of these giant flightless birds lived within the human period, although we have no historical evidence to this effect. The same is the case with regard to the large land-tortoises of Madagascar, two very fine shells of which have been acquired within the last few years.

From the foregoing observations it will be gathered that the new discoveries regarding the latest extinct animals of Madagascar merely serve to amplify our knowledge of the fauna, and in nowise invalidate the conclusions previously drawn as to its past history. Investigations carried on among the older rocks have, on the other hand, thrown an entirely new light on the state of the island during the secondary epoch of geological history, and have likewise a very important bearing on the evolution of the surface of the earth as a whole. For many years it has been known that marine rocks of Jurassic and Cretaceous age occur on the west side of the island, but there does not appear to have been any decisive evidence that during these epochs Madagascar itself was in existence. The recent discovery of remains of land reptiles corresponding very closely with some of those from the Jurassic rocks of Europe, enables us now to say with confidence that land here existed in this region from at least the date of the earlier of the two epochs in question. The first of these two reptiles is known by portions of the skull and jaws, which prove that it belonged to a European Jurassic genus of long-snouted primitive crocodiles, to which the name of *Steneosaurus* has been applied, this genus having been hitherto unknown elsewhere than in Europe. Still more interesting are a number of gigantic vertebræ and limb-bones described in a paper just read by the writer before the Geological Society. If our readers can recall an article entitled "Giant Land Reptiles," published some years ago in Knowledge,* they may remember that the so-called dinosaurs are divided into three main groups, one of which has been designated by the name of sauropodous, or lizard-footed. These enormous reptiles, which are the largest known to science, and are well represented in the Jurassic and Cretaceous rocks both of Europe and the United States, are specially characterized by the presence of large cavities on each side of the vertebræ of the neck and trunk, such cavities generally communicating with honeycomb-like excavations in the body of the bone itself. The Malagasy representative of the group, which appears to have been fully as large as its European cousins, belongs to a hitherto very imperfectly known genus, first described from the Jurassic rocks of England, under the name of *Bothriospondylus*. Thanks to the new specimens, we are now enabled to state that this genus differs from the others of the group in that the lateral cavities of the vertebræ had no connection with any honeycombing of the interior, which was, in fact, solid. Interesting as is this circumstance, it fades into insignificance in comparison with the light thrown by these and other representatives of the same group on the past history of the globe in general.

* Republished in "Forms and Phases of Animal Life," by the present author.

XUM

We have said that sauropodous dinosaurs have long been known from Europe and North America, and some years ago the writer had the good fortune to make known the occurrence of a member of the same group in the Cretaceous rocks of India, under the name of *Titanosaurus*. The same genus was subsequently identified from the corresponding rocks of England, and only last year the writer was enabled to describe the remains of yet another species from the approximately corresponding deposits of Patagonia.

We have thus evidence that gigantic sauropodous dinosaurs ranged over Europe, India, Madagascar, and North and South America during the Jurassic and Cretaceous periods; one of the genera being common to such widely-separated areas as Madagascar and England, and a second to India, England and South America, while several probably ranged over Europe and the United States. It is further evident that when the *Bothriospondylus* flourished in Madagascar, that island was joined to Africa, as it is most unlikely that such a gigantic animal could have been restricted to such a comparatively small area as the former; and we may accordingly assume that the group then ranged over Africa, which we know from other evidence to have been land during the epoch in question. Accordingly, we conclude that during Jurassic and early Cretaceous times almost the entire world was inhabited by closely-allied gigantic land reptiles, and thus not only that its fauna was practically similar, but that all the great continents were intimately connected with one another, and that the insulation of large areas like peninsular India, Africa south of the Sahara, and South America, which formed such a remarkable feature of early Tertiary geography, was then quite unknown. Since Australia, at or about the same epoch, was apparently more or less closely connected with Asia, we conclude that both the evolution of distinct regional faunas and the separation of large southern island-continents (now, for the most part, reunited with more northern lands) took place during the Tertiary period.

We may mention, in conclusion, that geologically Madagascar may be roughly divided into two distinct areas by a north-and-south bisecting line. To the right, or east, of this line the country is composed of granite, gneiss, basalt, and other rocks of igneous origin; while to the left, or western, side it consists of sedimentary strata ranging in age from the Jurassic to the Tertiary epoch. The old crystalline area may very probably have existed as land ever since the period when the giant dinosaurs ranged over its surface; and it may be suggested that the Jurassic and Cretaceous sea separating this old land from the continent was merely a gulf, and that either the southern or northern extremity of Madagascar was then in union with the mainland.

THE FACE OF THE SKY FOR MARCH.

By Herbert Sadler, F.R.A.S.

FINE groups of spots still occasionally appear on the solar surface. There will be a small partial eclipse of the Sun on the morning of the 25th (magnitude of the greatest phase 0·36) which is just visible at Greenwich, where the eclipse commences at 9h. 56m. A.M., at an angle of 49° from the north pole towards the west; greatest phase 10h. 10m. A.M. (magnitude about $\frac{1}{100}$th); ends at 10h. 23m. A.M. Conditions improve as we go west, about $\frac{1}{10}$th of the disc being obscured in the west of Ireland. Conveniently observable minima of Algol occur at 9h. 39m. P.M. on the 19th, and 6h. 28m. P.M. on the 22nd.

Mercury is too near the Sun during March to be available for the purposes of the amateur.

Venus is an evening star, and is getting into a better position for observation. On the 1st she sets at 7h. 38m. P.M., or 2h. after the Sun, with a southern declination of 0° 3′, and an apparent diameter of $10\frac{3}{4}''$, $\frac{93}{100}$ths of the disc being illuminated. On the 12th she sets at 8h. 13m. P.M., with a southern declination of 5° 38′, and an apparent diameter of 11·0″, $\frac{91}{100}$ths of the disc being illuminated. On the 22nd she sets at 8h. 45m. P.M., or two hours and a half after the Sun, with a northern declination of 10° 36″, and an apparent diameter of $11\frac{1}{2}''$, $\frac{89}{100}$ths of the disc being illuminated. On the 31st she sets at 9h. 14m. P.M., or two hours and three-quarters after the Sun, with a northern declination of 14° 44′, and an apparent diameter of $11\frac{3}{4}''$, $\frac{87}{100}$ths of the disc being illuminated. During the month she passes through Pisces into Aries, without approaching any conspicuous star very closely.

Mars is, for the purposes of the amateur, invisible.

Jupiter is an evening star, and is well situated for observation. On the 1st he sets at 3h. 26m. A.M., with a northern declination of 23° 21′, and an apparent equatorial diameter of 40·5″, the phase on the *f* limb amounting to 0·35″. On the 13th he sets at 2h. 41m. A.M., with a northern declination of 23° 23′, and an apparent equatorial diameter of 39″. On the 23rd he sets at 2h. 6m. A.M., with a northern declination or 23° 26′, and an apparent equatorial diameter of $37\frac{3}{4}''$. On the 31st he sets at 1h. 33m. A.M., with a northern declination of 23° 27′, and an apparent equatorial diameter of 36·8″. He is in quadrature with the Sun on the 18th. During March he describes a direct path in Gemini. The following phenomena of the satellites occur while the Sun is more than 8° below and Jupiter 8° above the horizon:—On the 5th an occultation disappearance of the third satellite at 7h. 53m. P.M., and its occultation reappearance at 10h. 48m. P.M.; an occultation disappearance of the second satellite at 11h. 6m. P.M. On the 6th a transit ingress of the first satellite at 0h. 42m. A.M.; an eclipse disappearance of the third satellite at 1h. 4m. 43s. A.M.; on this morning, from 1h. 5m. A.M. to 3h. A.M., Jupiter will appear to be attended by one satellite only, the fourth; an occultation disappearance of the first satellite at 9h. 56m. P.M. On the 7th an eclipse reappearance of the first satellite at 1h. 28m. 3s. A.M.; a transit ingress of the first satellite at 7h. 10m. P.M.; a transit ingress of the shadow of the second satellite at 8h. 16m. P.M., a transit egress of the satellite itself at 8h. 23m. P.M.; a transit ingress of the shadow of the first satellite at 8h. 27m. P.M.; a transit egress of the first satellite at 9h. 27m. P.M., a transit egress of its shadow at 10h. 45m. P.M.; a transit egress of the shadow of the second satellite at 10h. 57m. P.M. On the 8th an eclipse disappearance of the fourth satellite at 7h. 24m. 14s. P.M., an eclipse reappearance of the first satellite at 7h. 57m. 3s. P.M., an eclipse reappearance of the fourth satellite at 9h. 18m. 28s. P.M. On the 12th an occultation disappearance of the third satellite at 11h. 49m. P.M. On the 13th an occultation disappearance of the first satellite at 11h. 51m. P.M. On the 14th a transit ingress of the second satellite at 8h. 21m. P.M.; a transit ingress of the first satellite at 9h. 4m. P.M.; a transit ingress of the shadow of the first satellite at 10h. 22m. P.M.; a transit ingress of the shadow of the second satellite at 10h. 54m. P.M.; a transit egress of the second satellite at 10h. 59m. P.M.; a transit egress of the first satellite at 11h. 21m. P.M. On the 15th a transit egress of the shadow of the first satellite at 0h. 40m. A.M.; an eclipse reappearance of the first satellite at 9h. 52m. 48s. P.M. On the 16th a transit ingress of the shadow of the third satellite at

7h. 8m. P.M.; a transit egress of the shadow of the first satellite at 7h. 9m. P.M.; an eclipse reappearance of the second satellite at 8h. 7m. 6s. P.M.; a transit egress of the shadow of the third satellite at 10h. 12m. P.M. On the 21st a transit ingress of both the first and second satellites at 10h. 59m. P.M. On the 22nd a transit ingress of the shadow of the first satellite at 0h. 18m. A.M.; an occultation disappearance of the first satellite at 8h. 15m. P.M.; an eclipse reappearance of the first satellite at 11h. 48m. 33s. P.M. On the 23rd a transit egress of the first satellite at 7h. 45m. P.M.; a transit egress of the third satellite at 8h. 52m. P.M.; a transit egress of the shadow of the first satellite at 9h. 4m. P.M.; an eclipse reappearance of the second satellite at 10h. 42m. 34s. P.M.; a transit ingress of the shadow of the third satellite at 11h. 8m. P.M. On the 29th an occultation disappearance of the first satellite at 10h. 12m. P.M. On the 30th a transit ingress of the first satellite at 7h. 24m. P.M.; an occultation disappearance of the second satellite at 8h. 8m. P.M.; a transit ingress of the shadow of the first satellite at 8h. 41m. P.M.; a transit egress of the first satellite at 9h. 41m. P.M.; a transit ingress of the third satellite at 10h. 0m. P.M.; a transit egress of the shadow of the first satellite at 10h. 59m. P.M. On the 31st an eclipse reappearance of the first satellite at 8h. 13m. 10s. P.M.

Saturn is an evening star in March, in the sense of rising before midnight. On the 1st he rises at 10h. 39m. P.M., with a southern declination of 11° 25′, and an apparent equatorial diameter of 9·1″ (the major axis of the ring-system being 41¾″ in diameter, and the minor 13″). On the 12th he rises at 9h. 53m. P.M., with a southern declination of 11° 15′, and an apparent equatorial diameter of 9·2″ (the major axis of the ring-system being 42⅓″ in diameter, and the minor 13¼″). On the 22nd he rises at 9h. 11m. P.M., with a southern declination of 11° 4′, and an apparent equatorial diameter of 9·3″ (the major axis of the ring-system being 42¾″ in diameter, and the minor 13¼″). On the 31st he rises at 8h. 32m. P.M., with a southern declination of 10° 52′, and an apparent equatorial diameter of 9·4″ (the major axis of the ring-system being 43¼″ in diameter, and the minor 13¼″). Titan is at his greatest eastern elongation at 10h. P.M. on the 14th, and 8½h. P.M. on the 30th. Iapetus is in inferior conjunction on the 14th. During March, Saturn pursues a short retrograde path in Virgo, to the north-east of λ Virginis.

Uranus rises at midnight on the 1st, with a southern declination of 17° 23′, and an apparent diameter of 3·8″. On the 31st he rises at 9h. 58m. P.M., with a southern declination of 17° 15′. During March he pursues a retrograde path in Libra, being very near the 6½ magnitude star 26 Libræ towards the end of the month.

Neptune is an evening star, and is still well situated for observation. On the 1st he sets at 2h. 14m. A.M., with an apparent diameter of 2·6″, and a northern declination of 20° 55′. On the 31st he sets at 0h. 14m. A.M., with a northern declination of 20° 59′. During March he describes a short direct path to the south-west of ε Tauri.

March is not a very favourable month for shooting stars.

The zodiacal light should be looked for after sunset in the south-west during the absence of the Moon.

The Moon enters her first quarter at 0h. 40m. P.M. on the 4th; is full at 3h. 38m. A.M. on the 11th; enters her last quarter at 5h. 32m. P.M. on the 18th; and is new at 10h. 25m. A.M. on the 26th. She is in perigee at 1h. A.M. on the 10th (distance from the earth 223,220 miles), and in apogee at 7h. A.M. on the 22nd (distance from the earth 251,960 miles). There will be a total eclipse of the Moon on the morning of the 11th; magnitude of the eclipse (Moon's diameter = 1), 1·61. The first contact with the penumbra takes place at 0h. 58m. A.M., with the shadow at 1h. 54m. A.M. (at 127° from the northernmost point of the limb towards the east); commencement of totality, 2h. 52m. A.M.; middle of total phase, 3h. 39m. A.M.; end of totality, 4h. 27m. A.M.; last contact with shadow, 5h. 24m. A.M. (at 69° towards the west); last contact with penumbra, 6h. 20m. A.M. Sun rises 6h. 26m. A.M.

Chess Column.

By C. D. Locock, B.A.Oxon.

COMMUNICATIONS for this column should be addressed to C. D. Locock, Burwash, Sussex, and posted on or before the 12th of each month.

Solution of February Problem (A. G. Fellowes).

Key-move—1. P to Kt3.

If 1. . . . K to K4, 2. B to B6ch, or 2. Kt to K6, etc.
1. . . . K to Kt6, 2. Kt to K6, or 2. Kt to B5ch, etc.
1. . . . K to K6, 2. R to K2ch, etc.

This problem appears to abound in dual or even triple continuations. It seems unnecessary to print them all.

CORRECT SOLUTIONS received from Alpha, J. T. Blakemore, N. Alliston, F. G. Ackerley, F. V. Louis, A. Louis, W. Willby, E. W. Brook.

Additional solutions of January problems have been received from Beta (No. 1), J. M'Robert (No. 2).

Alpha.—It seems doubtful whether our solvers would try a five-move problem. Three moves are, as usual, the popular limit.

A. C. Challenger.—Many thanks for the problem, which appears below.

J. T. Blakemore.—Thanks. It shall appear next month.

N. Alliston.—Key perhaps rather weak, but the problem seems sound, and is marked for publication.

F. G. Ackerley.—The whole of your solution is not quite intelligible, but you evidently intend the correct key.

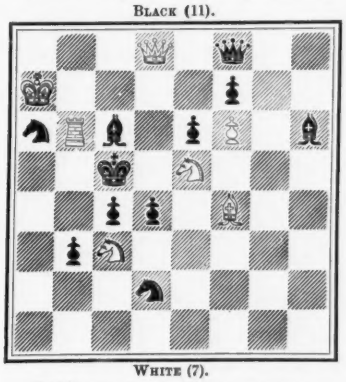
We have received for review *The Art of Chess*, by James Mason (Horace Cox), price five shillings net.

We have also received a collection of *One Hundred Chess Problems*, by E. Orsini, one of the most prominent Italian composers. The specimens, one of which is appended below, range from two-move direct mates up to a seventeen-move sui-mate.

PROBLEMS.

No. 1. By E. ORSINI (Selected).

BLACK (11).

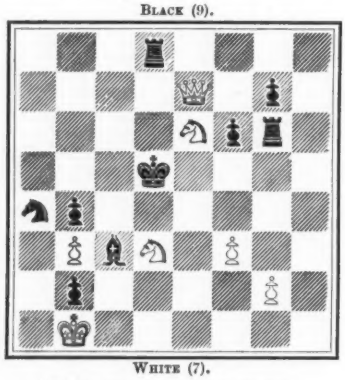


WHITE (7).

White mates in three moves.

No. 2. By A. C. Challenger.

Black (9).



White (7).

White mates in two moves.

CHESS INTELLIGENCE.

We have received the following letter for publication. The Hastings Chess Club has lately occupied a very prominent position in the Chess world, and we hope that their enterprising action will meet with the success that it deserves. The Chess Editor of Knowledge will gladly receive and acknowledge in this column any subscriptions towards the tournament fund.

INTERNATIONAL CHESS TOURNAMENT.

Hastings and St. Leonards Chess Club.
February 1st, 1895.

Dear Mr. Editor,—There have been frequent statements in the Press of late that it is desirable to hold an International Chess Tournament in England this year, and a wish has been expressed that some club would take the matter up.

As it is nearly five years since the Manchester Tournament was held, the time is surely ripe for another meeting of the English and foreign masters.

Acting on these considerations, the executive of the Hastings and St. Leonards Chess Club, first sought, and obtained, the promise of cordial support from the Chess editors of the principal London papers.

An endeavour was then made to see what funds could be raised locally, and the president, John Watney, Esq., and one of the vice-presidents, Horace Chapman, Esq., at once gave a promise of £50 each, and the club and its friends in the town responded with further contributions of about £150, making a total of £250 up to the present time.

The committee consider that in these circumstances they are justified in applying to the Chess players of the United Kingdom to give them their generous support, financially and otherwise, so that the tournament may be a complete success.

As the co-operation of the entire Chess community is anxiously sought, a notice will be sent immediately to every club and association in the United Kingdom, asking for assistance, and seeking permission to add the name of its president to the list of patrons.

It is intended to hold the tournament in Hastings in August, and as it is a very popular seaside resort, within easy distance of London, the situation is convenient.

The committee propose to allow a month from now to elapse for the receipt of letters of support and further subscriptions, before issuing a fuller statement of plans and arrangements.

It is hoped that the subscriptions will be sufficient to enable a minor tournament to be played at the same time.

Contributions may be sent to the Hon. Treasurer, A. H. Hull, Esq., 33, London Road, St. Leonards, or may be paid direct into the "International Chess Tournament Fund," at the London and County Bank, Hastings.

Hoping that the course taken will commend itself to the Chess world,

I remain, sir, yours faithfully,
Herbert E. Dobell, *Hon. Sec.*

The match played at Paris between Janowsky and Mieses terminated in a draw. Each player won six games, and two were drawn. The games are not free from oversights, especially on the part of the German player, but there are some good examples of Janowsky's elegant style of conducting a winning attack.

The match by cable between the British Chess Club, London, and the Manhattan Club, New York, is definitely fixed for Saturday, March 9th. Each club will be represented by ten players.

The match played at the Manhattan Club between Messrs. J. W. Showalter and A. Albin terminated, after a protracted struggle, in a victory for the American amateur, the final score being Showalter 10, Albin 7, drawn 8.

In the Southern Counties Chess Union, Surrey have scored an easy victory over Hants, while Sussex have beaten Kent by default. Should Surrey succeed in defeating Kent, the tie match between Surrey and Sussex will probably be replayed.

The Hastings Chess Festival was this year again a great success. The consultation games resulted as follows:—J. H. Blackburne and Dr. Colborne beat I. Gunsberg and Dr. Balingall; I. Gunsberg and C. D. Locock beat H. E. Bird and F. W. Womersley; H. E. Bird and H. Chapman beat J. H. Blackburne and E. Gillies.

Mr. Blackburne's blindfold performance against an unusually strong local team resulted in four wins to the single player, and two drawn games with Messrs. Womersley and Aloof.

Simultaneous exhibitions were given by Messrs. Bird and Gunsberg. Mr. Gunsberg's score was—won 20, drawn 2, lost 2. Mr. Bird was not quite so successful, his state of health being evidently unequal to the severe strain.

The proceedings on the last day were varied by a visit from the Athenæum Chess Club, London, who played an interesting match with the Hastings Club. The match ended in a tie; the local club, aided by some luck, being signally successful on the top boards.

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